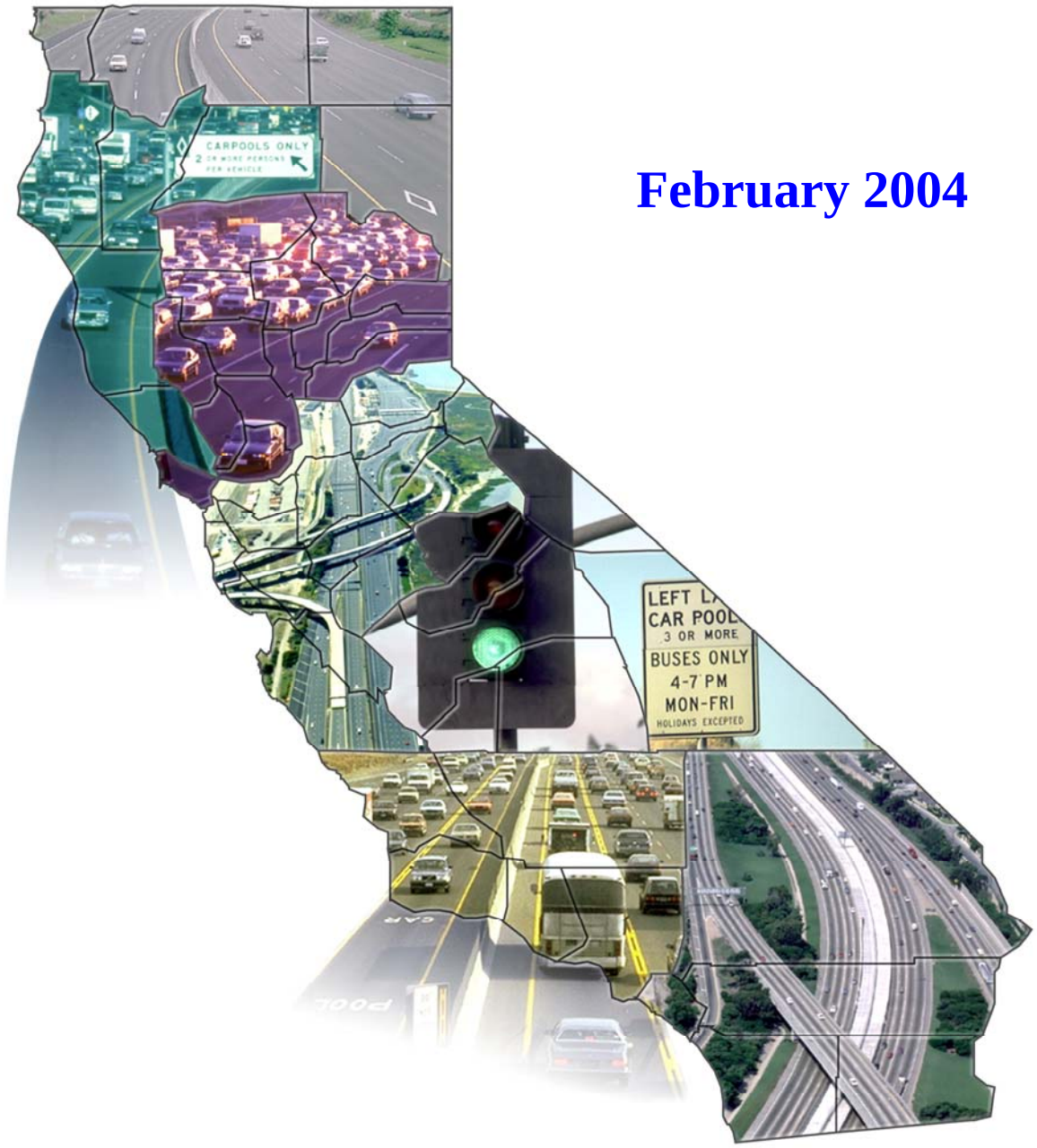
Transportation Management System Master Plan



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System Metrics Group, Inc.

Transportation Management System (TMS) Master Plan

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I. Summary

Business is about developing a viable product or service, delivering it to the market, and managing the enterprise to do both effectively. Business success is dependent upon: knowing the market, designing something the market values, and delivering it at a recoverable cost and price the market is willing to bear.

The principles for managing an enterprise evolve over time. While a publicly traded company may focus continuously on maximizing shareholder value, the methods necessary to achieve success change as the company matures. Growth is critical during the early stages of many businesses. Accordingly, an organization may focus on growth strategies, such as capital investments, acquisitions, and opportunistic expansion. As the business matures, the focus shifts from growth to productive operations. This evolution is natural for a manufacturing company, an airline, a retailer, or a service enterprise. It is also inevitable for the California Department of Transportation (Department) and its partners.

California's transportation system has matured and its initial growth phase is nearing its end. The system is largely built and California expands its transportation infrastructure by only a fraction of a percent each year. When expansion is necessary, the Department and its partners choose projects strategically to get the biggest return on what are very expensive investments. Despite these investments, highway congestion continues to grow in California's urban regions at nearly five times the rate of population growth. Californians experienced double the congestion in 2000 compared to 1990.[1] Population and employment projections suggest congestion will double again this decade unless the Department and its partners manage to improve the productivity of the transportation system and restore lost capacity.

The Department and its regional and local partners recognize that addressing congestion requires a multi-pronged approach that includes: adding new capacity, maintaining its infrastructure, investing in and encouraging the use of alternate modes such as transit and rail, and transportation management systems (TMS) and strategies. In fact, the Department has approximately $7 billion of such work under way that reflects this multi-pronged approach, which is referred to as "system management" and discussed in more detail throughout this report.

Restoring lost capacity is a central theme of system management. As congestion has increased, the highway system's productivity has diminished, sometimes as much as 50 percent during the peak commute periods. Just when the highway system needs to "serve" the most customers per hour, it actually serves the fewest. Imagine a fast food restaurant with fewer cashiers during the busy lunch hour. Recovering some of the lost productivity requires adoption of the operational strategies discussed first in the Traffic Operations Strategy (TOPS) report submitted to the California State Legislature in 2000. These strategies include small operational improvement investments that adjust highway

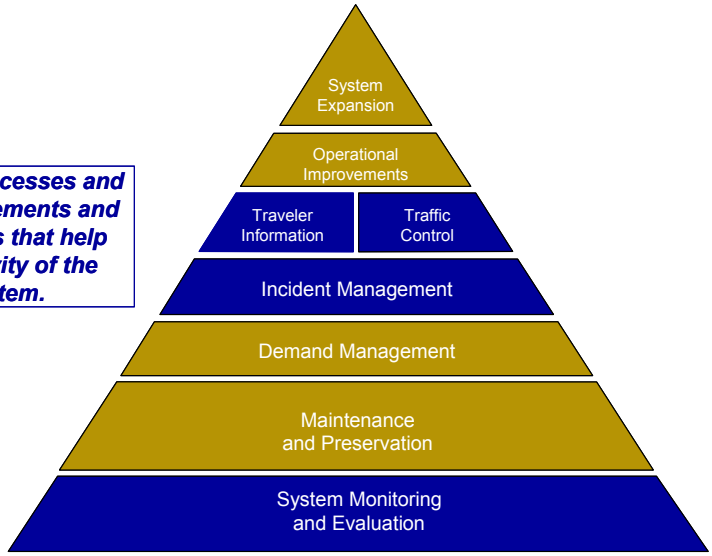
[1] Source: Department of Finance

infrastructure to reduce bottlenecks. The strategies also include improvements in three core business processes that are essential for improved operations: traffic control, traveler information and incident management. These processes rely heavily on technology to manage growing congestion and are generally referred to as the Transportation Management System (TMS). In today's transportation environment, TMS are increasingly critical, particularly in light of the general consensus in the transportation community that capital-intensive infrastructure projects are not enough to meet mobility needs, today and in the future.

This report summarizes the Department's action plan for core TMS processes and describes the expected benefits for more effective system management and improved business processes. The plan recognizes that an evolution in the way the Department does business is necessary. The Department must work closely with and rely heavily on its partners – including the Department of California Highway Patrol (CHP), regional agencies, counties, and local cities – in order to enable it to change. However, the plan also commits the Department and its partners to demonstrate the benefits of this transformation to its partners, the California State Legislature (Legislature) and control agencies each step of the way. The new business model has to be TOPS-style system management, which incorporates TMS, operational improvements, demand management, maintenance and operations, and selective system expansion, as illustrated in Exhibit I-1. The difference between this approach and previous models for managing California's transportation system is an emphasis on the middle sections of the triangle (incident management, traveler information, and traffic control), which are all operational processes. The success of these processes depends on the availability of real-time performance information (found at the base of the triangle), reflecting a new focus on maximizing the system's productivity. It also depends on the Department and the regional and local agencies working closely together and coordinating their technology initiatives and funding priorities.

Exhibit I-1: System Management Framework

TMS are the business processes and associated tools, field elements and communication systems that help maximize the productivity of the transportation system.



The TMS Master Plan outlines several commitments and guiding principles for TMS:

- The Department is committed to system management as an overall way of doing business and recognizes that operational business processes are critical components of the approach.

- The Department recognizes that any success with TMS requires close coordination with and reliance on its state, regional, and local partners. The Department will therefore work with and rely upon regional and local agencies to address challenging strategies, such as ramp metering implementation. Coordination and commitment will be critical for successful implementation of the TMS Master Plan.

- The Department will work with regional agencies to identify and secure new funding sources for expediting implementation of the TMS Master Plan.

- The Department is committed to integrating performance measurement into every aspect of planning and operations so that stakeholders understand current system performance, future scenarios, and system management options. As part of performance measurement, the Department will report regularly on the benefits achieved to provide accountability at every level.

- The Department is committed to integrate its planning and operations activities and improve its tools to better plan for TMS strategies.

- The Department is committed to improving the reliability of its current detection systems first and then expanding detection coverage to all needed areas. Data gathered from this detection will be shared with the Department's regional and local partners, the private sector, and most importantly travelers who function as system co-managers.

- The Department will build on previous system development efforts, enhance current systems, and ensure that each region in the State has similar functionality to manage its system. Enhancements to existing systems will be justified and reviewed by State and regional partners before implementation.

- The Department will redirect resources internally as needed to ensure that the analysis and evaluation of operations is integrated throughout the organization, including the Division of Planning.

- The Department will meet all federal regulations related to the design and deployment of technology-based transportation systems and ensure consistency with regional plans and adherence to State Information Technology rules.

- The Department is focusing on core TMS and recognizes that other State-managed TMS (such as those related to transit) are in earlier stages of development. The Department has initiated a new effort to complement the TMS Master Plan with a plan for other TMS. This effort will also address federal regulations.

The Department expects these commitments and full implementation of the action plan to generate many benefits for Californians:

- At least a 20-percent reduction in congestion statewide and a commensurate increase in freeway productivity by restoring lost capacity.
- Travel reliability or predictability improvements of at least 20 percent (benefiting commuters and truckers alike).
- Increased safety on California highways.
- Improved ability to respond to natural disasters.
- Better security preparedness, as Department staff are able to monitor almost every mile of the urban freeway system and eventually key interregional corridors.

The remainder of this document discusses the background, issues, benefits and action plan for TMS in more detail. As shown in Table I-1, it addresses the requirements set forth in the 2001 budget language with more detail available under separate covers.

Table I-1: Budget Language Requirements

Reporting Requirement	**Section ……..……Page(s)**
(a) A description of the current business processes for managing the transportation system and an assessment of current practices.	TMS Business Process Review Report (under separate cover) Section II Background ……..…..……Page 9 Section V Major Issues ……Page 20
(b) Definitions of the roles and responsibilities of various entities, including the Department, the CHP, and regional transportation planning agencies, with regard to incident management and recurrent congestion.	Section III Roles and Responsibilities.....Page 12
(c) A description of the conditions under which co-location of State transportation management centers and local transportation management centers or CHP communication centers is cost effective and desirable.	Section III Roles and Responsibilities...Page 15
(d) A list of specific measurable objectives and performance measures for system management and how each element and strategy contributes towards those objectives.	Section VI Goals and Objectives ……Page 22
(e) An action plan for improving traffic management that will ensure statewide consistency and coordination of transportation management center activities.	Section VIII Action Plan ……Page 30 Action Plan Schedule …Attachment

II. Background

Californians are experiencing ever increasing congestion on the State's urban highway system. During commute periods alone, recurrent freeway congestion has more than doubled over the last decade and congestion has begun to appear during non-commute periods as well. These statistics exclude congestion due to incidents such as accidents, severe weather conditions and special events, which can cause additional delays for the public. Over the ten-year period, recurrent congestion grew almost five times faster than the State's population. These trends threaten to undermine California's long-term economic growth.

Californians appear to be acutely aware of rising congestion. Frustrated commuters not only commended the approval of additional transportation funding in Governor Davis' Transportation Congestion Relief Program (TCRP), but a majority also approved a number of regional sales tax and bond propositions promising a measure of congestion relief. Despite the increases in funding, most regional transportation agencies project worsening conditions over the next decade and other transportation professionals agree with these forecasts.

Worsening congestion is a continuation of the historical trends. Exhibit II-1 presents delays due to severe congestion in California during weekday peak commute times (excluding the impacts of incidents) over the last 15 years.

Exhibit II-1: Recurrent Delays in California during the Weekday Peak Commute

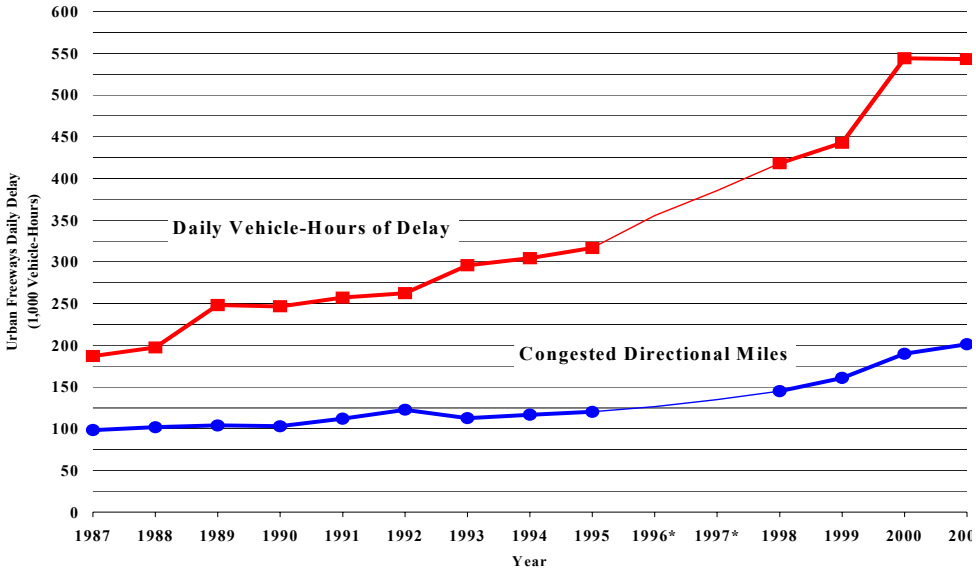


Exhibit II-1 also displays trends in total congested (directional) miles. Delay has increased faster than congested miles. This means that some delay increases can be attributed to appearance of congestion in new locations, while the rest reflects increases in the severity of congestion in existing locations.

TCRP, sales tax, and bond funds are beginning to address congestion growth, but they are only a portion of the State's system management strategy. Most of the new funds are targeted towards capacity-enhancing projects. While multi-modal, these projects are generally larger and address specific bottlenecks or corridors. The Department is committed to expedite delivery of these projects on the freeway system and has accomplished an unprecedented rate of project delivery over the last two years. Yet, it is important to understand fully the causes of congestion and develop multi-faceted strategies to complement capacity-enhancing investments.

The Department developed and submitted the Traffic Operations Strategies (TOPS) report to the Legislature in 2000. This report describes a multi-faceted, system management approach in some detail. The TMS Master Plan compliments this approach. The Department and its partners must ensure that the State gets every bit of productivity out of the existing system.

The TMS Master Plan recognizes an evolution in the way the Department does business is necessary. The Department will need to work closely with its partners – including the CHP, regional agencies, counties, and local cities – in order to enable it to change. However, the plan also commits the Department to demonstrate the benefits of this transformation to its partners, the Legislature and control agencies each step of the way.

In order to appreciate fully the transportation challenges facing California, the Department, and its partners, one must understand the notion of highway productivity.

What is Highway Productivity?

Productivity for transportation systems is not very different from productivity for any business or enterprise. It reflects the number of products or amount of services provided per unit of input. For example, the banking industry can measure the number of transactions conducted and customers served by each teller.

Banks have addressed an increase in demand during certain hours by deploying automatic teller machines (ATMs). Similarly, manufacturing companies have automated many processes through robotic advances and increased their output without building new factories. Private air carriers now sell tickets through a variety of websites, which reduce the need to open new sales offices.

In transit, productive rail systems carry a larger number of patrons per hour during peak commute times. The Bay Area Rapid Transit (BART) District increases the number of trains during peak commute periods and serves an increasing number of patrons across the San Francisco Bay every morning. BART now carries at least 30 percent more riders on weekdays than it did ten years ago.

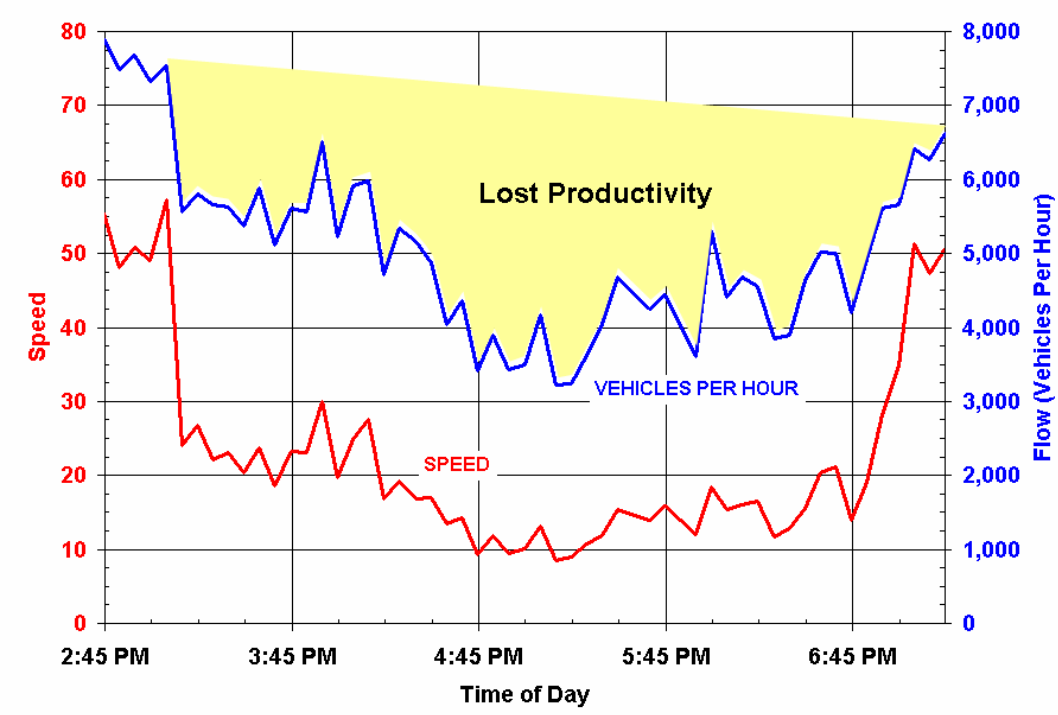
Unfortunately, these same principles do not apply to freeways. In fact, freeway productivity, defined as the total number of vehicles (and the people inside) served per

hour at a given location, actually diminishes when demand is highest. We need a way to restore the lost capacity.

A recent Department analysis suggests that almost half of the urban freeway system in California provides a level of productivity that is 25 to 35 percent below planned capacity levels during peak congested periods. Productivity can get only worse in the future, since California's population is expected to continue to grow. Without a significant improvement in productivity on the existing system, investments in capacity expansion will not be enough to compensate for further reductions in highway productivity.

Exhibit II-2 illustrates the concept of lost productivity using data from State Route 22 in Orange County. All four lanes of State Route 22 show a significant loss in productivity once severe congestion starts. The shaded area represents lost productivity. Congestion lasts for almost four hours. Speeds remain consistently under 35 miles per hour, and productivity per lane drops to as low as 50 percent and is hardly above 60 percent for most of the time that congestion is present.

Exhibit II-2: Productivity Loss during Severe Congestion



This situation is not hopeless. Transportation experts around the world have developed concepts and tools to help restore part, if not all, of the lost productivity. The solutions are not easy to implement and require tough decisions. The Department and its partners must implement advanced operational strategies, collaborate with their customers to manage demand, and expand the system strategically. More than ever before, transportation professionals need an in-depth understanding of current and projected system performance and must be able to leverage new technologies and tools to improve

the productivity of the system. This is a full system management approach to providing and improving transportation. The Transportation Management System is a critical component of this system management approach.

What is the Transportation Management System (TMS)?

The TMS is the business processes and associated tools, field elements and communications systems that help maximize the productivity of the transportation system. They are essential if the State is to get the most out of its current system.

The private sector uses similar systems to improve its operations. Retail firms have gained tremendous productivity by implementing systems that improve logistics, minimizing the need for expensive warehousing and transportation costs. Manufacturing companies have implemented automation technologies to produce more with less. Banks have achieved previously unattainable productivity levels by deploying automatic teller machines (ATMs) and sophisticated web services all over the globe.

In transit, TMS includes automated train control systems that help rail agencies reduce the distance between trains and increase the frequency of service. BART plans to address growing demand across the San Francisco Bay by implementing just such a system. BART will be able to provide more trains and serve more customers during the peak period without expanding its physical infrastructure.

Similar productivity gains can be achieved on freeways by implementing TMS. However, freeway productivity has a subtle difference from the previous examples – productivity shrinks when demand is high. For freeways, the Department and its partners need to overcome a double hurdle consisting of higher demand and lower productivity.

As a result of this hurdle, the Department has chosen to focus on three core TMS processes that help to regain lost productivity in congestion for inclusion in the TMS Master Plan. This core includes traffic control and management systems, incident management systems, and advanced traveler information systems. All three processes rely on real-time, advanced detection systems. These TMS processes and their associated detection systems represent the nucleus for the Department's traffic operations strategies, form a critical part of the overall system management strategy, and are the focus of this report.

The TMS Master Plan does not address other TMS, such as automatic toll collection, public transit, and goods movement. The Department recognizes they are also important for state highway operations and has embarked on a complementary effort to address other TMS.

Below is a brief summary of each TMS process included in the TMS Master Plan:

Traffic Control – A proven strategy

Traffic control refers to signal strategies for managing traffic flows on arterials as well as ramp metering at the entrances to and exits from the freeway system. These strategies offer great promise to improve the productivity of our transportation system, but also pose significant challenges for the State in terms of local and regional acceptance.

Local agencies and communities often object to ramp metering because of the additional traffic that may use local streets and limited understanding of how all agencies can best work together.

Incident Management – The need for travel time reliability

Today's incident management relies on advanced technologies to expedite incident detection, verification, and clearance, thereby mitigating the negative impacts of incidents, special events, and severe weather conditions. Given that most studies in the United States suggest that incidents are responsible for about half the delays on our freeway system, even a small improvement in this process can yield significant benefits. Travelers experience these benefits as more predictable travel times, increased safety, and reductions in incident-related delays.

Advanced Traveler Information Systems – A partnership framework

Advanced traveler information systems are relatively new technologies that offer tremendous promise. Currently, most commuters get information about traffic conditions from media outlets, such as radio stations. Advanced traveler information can be tailored to individuals and reflect a true partnership between transportation agencies and the public. This type of partnership could help level modal and time-of-day demand to help California get the most out of its transportation system. Concurrently, advanced traveler information empowers travelers to manage their trips in the most efficient manner. However, it is clear that transportation agencies have not developed fully the framework for such a partnership and that current detection systems are not adequate for real-time, tailored information.

These three TMS processes require some supporting elements to perform their functions and achieve intended benefits. Two of the supporting elements, detection and Transportation Management Centers (TMCs) are discussed in more detail below:

Detection – The base for all system management strategies

Detection refers to real-time measurement of transportation movements and conditions. Contrary to past practices, where measurements were done periodically (e.g., once a year) to determine the relative need for infrastructure expansion, an operations-focused system management approach requires more accurate, on-going data collection. The TMS requires real-time data and storage of detailed day-to-day, hour-by-hour information for subsequent planning and predictive travel analysis.

Without such detection, transportation agencies cannot implement advanced traffic control strategies; cannot inform the public about traffic conditions, expected delays and options; and cannot detect and react to incidents quickly enough to minimize their impacts on transportation flows.

Transportation Management Centers – An integrated environment

TMCs play a critical role in the TMS. They provide an integrated environment in which to operate. First, all three TMS processes require real-time communication with thousands of field elements, such as detection stations and changeable message signs (CMS). The TMC provides a centralized environment that allows coordinated responses and actions to take place. Second, the TMS requires integration across systems. For instance, ramp metering and arterial signal management need to be integrated functionally in the near future. Similarly, traveler information requires the sharing of the detection data with public and private partners, which in turn requires integration with the State communication network. Third, different agencies (e.g., the Department, CHP, and the media) play different roles using different systems for incident management. Integrating these roles and systems in one location is critical to better performance. As a result, TMCs play an increasingly important role in day-to-day system management.

Moreover, TMCs are used in emergencies, providing an Emergency Operations Center function (e.g., during earthquakes). TMCs also serve a security preparedness function since staff can monitor the urban freeway system, quickly activate response strategies (e.g., using changeable message signs), or notify the proper authorities when security risks are identified.

Finally, the high level of face to face coordination required between CHP and the Department during AMBER alerts further proves the effectiveness of this close cooperation.

III. Roles and Responsibilities

When traveling in cars, buses, trains, cycling or even walking, Californians usually cross several jurisdictions. A single trip can include driving on local streets, local arterials, State conventional highways, and State freeways. However, jurisdictional boundaries are meaningless to the traveler, who cares more about the overall safety, mobility, and reliability of the trip. To provide Californians with the best service, State, regional, local, and operating agencies must integrate their planning, decision making, operational strategies and TMS. They share the common goal of providing mobility, modal choices, safety and reliability to their constituents. In moving towards a future with integrated and coordinated TMS, it is important to understand the roles and responsibilities of different agencies and the private sector regarding the TMS processes discussed in this report:

The California Department of Transportation: is the owner/operator of the State Highway System and is involved in each of the three TMS processes addressed in this TMS Master Plan. However, the Department neither owns nor operates most of the local roadway system that provides access to and from the State Highway System. It also does not manage or operate almost any of the transit systems that use or provide alternatives to the highway system. As a result, the Department must work very closely with all its stakeholder agencies to manage traffic.

Department of California Highway Patrol (CHP): is the lead agency for all incidents on the State Highway System and unincorporated county roads, and is therefore responsible for the safety of the public. It relies on a computer aided dispatch (CAD) system to manage incidents and provide information to other agencies and to the public. CHP is also responsible for dispatching Freeway Service Patrol (FSP) trucks to respond to call box requests for assistance or other incidents and is the lead agency during AMBER alerts.

Regional Agencies: include Metropolitan Planning Organizations (MPOs) and Regional Transportation Planning Agencies (RTPAs). The primary role of regional agencies is to develop regional plans that address capital projects and operational strategies. Another primary role is to gather and provide traveler information to the public. The larger agencies also coordinate the FSP and call box programs. Regional agencies control 75 percent of the State Transportation Improvement (STIP) funds and are responsible for developing regional architectures called for in federal rulemaking. The State must be consistent with all regional architectures, which requires significant coordination.

Local Transportation Agencies: such as city and county agencies are the owners/operators of the local roadway and transit systems that complement State and regional systems. TMS strategies that require technical integration of tools or implementation of technical strategies (e.g., ramp metering) also require the State and regional agencies to coordinate closely with local agencies to provide seamless travel choices and achieve benefits desired by the public. Some local agencies own and operate their own TMCs.

Private Sector: including value added resellers (VARs) that access the real-time information provided by public agencies and other sources to offer tailored traveler information services to the public. They take advantage of the emerging telematics technologies (e.g., in-vehicle navigation systems). In the future, these concerns can play a critical role in helping travelers understand their options before leaving their homes and during their travel trip. A fully informed public making better travel choices will help improve the balance between supply and demand on all transportation systems. VARs, sometimes referred to as Information Service Providers, are an emerging industry that can help the State's economy and maintain its technological advantage.

The three TMS processes addressed in this TMS Master Plan are a joint responsibility for all. Table III-1 details the responsibilities for detection and for the three TMS processes. Detection is not a TMS process, but is critical for all three.

Table III-1: Roles and Responsibilities for Detection and TMS Processes

Area	Responsibility	Lead Agency	Other Agencies Involved
Detection on the State Highway System	Collect, store, and provide access to State highway traffic data	The Department owns, maintains and operates detection devices and stores information in TMCs. The Department provides access to the information to public partners and commercial concerns.	Regional agencies sometimes fully or partially fund detection systems (via STIP or other funding sources such as CMAQ) and some are considering deploying their own detection technologies.
Traffic Control on the State Highway System	Install ramp metering equipment and connect to central ramp metering system	The Department designs ramps, and oversees contractors.	Regional agencies sometimes fund ramp meter installations.
	Manage central ramp metering system	The Department manages ramp metering in the TMCs using central software systems.	Regional agencies work with the Department and local agencies to agree on ramp metering strategies.
	Analyze traffic flows and develop/test new ramp metering algorithms	The Department operations staff test new algorithms and produce before and after reports.	Regional agencies often are involved with the analysis and sometimes conduct separate, but related studies.
	Coordinate ramp metering with State and other road signals	The Department and local agencies.	Regional agencies get involved in coordination and planning activities.
	Enforce ramp metering signals	CHP	
	Implement signals on state routes	The Department and local agencies.	The Department works with local agencies to determine when a traffic signal at an intersection is appropriate.
	Manage signals on state routes (including signal priority and actuation)	The Department and local agencies.	The Department works with local agencies to manage the timing patterns of signals.

Table III-1: Roles and Responsibilities for Detection and TMS Processes (continued)

Area	Responsibility	Lead Agency	Other Agencies Involved
Incident Management on the State Highway System	Detect incidents	CHP fields 911 and call-box calls and directs FSP actions. The Department sometimes detects accidents by analyzing traffic data.	Radio stations sometimes are called directly by travelers and generally relay the information to CHP. Regional agencies administer call-box programs.
	Provide weather condition and special advisory information (incident prevention)	The Department informs the public by activating the Highway Advisory Radio (HAR) systems.	Some regions post the information on their regional traveler information systems.
	Verify incidents	CHP verifies incidents in the field. The Department is sometimes able to verify the location and severity of incidents using Closed Circuit Television (CCTVs).	
	Inform the public of incidents and related impacts	The Department/CHP informs the media directly or via the CHP MediaCAD website. The Department also activates CMS to inform drivers.	Regional agencies and the State update their regional traveler information systems.
	Secure incident scene	CHP is the lead agency on the scene. It directs tow trucks and works with Department staff to secure scene.	
	Investigate incidents as needed	CHP	
	Manage traffic at major incident locations	The Department deploys Traffic Management Teams (TMTs).	
	Clear incidents	CHP directs private tow-trucks. The Department's maintenance staff performs road work.	
	Inform public of incident clearance and related impacts	The Department and CHP inform the media.	Regional agencies update their traveler information systems.
Traveler Information on the State Highway System	Inform public directly on traffic conditions	Regional agencies and the Department provide conditions on web sites.	Media informs travelers on traffic conditions using different channels.
	Provide information to partner agencies	The Department provides State Highway data. Local agencies provide transit and other data.	
	Provide information to private sector resellers	The Department provides State Highway data.	

Table III-1 illustrates how much coordination and cooperation is needed for agencies to perform their respective roles and responsibilities. Coordination is particularly important for the Department and the CHP. They play critical and dependent incident management roles, which is why co-location of these two agencies at TMCs is deemed so important.

Co-Location of Facilities

As with other aspects of TMS, TMC development has been evolutionary. As field element technologies progressed, the need for a central place to control these elements grew. Information technology costs continue to decrease and the value that information technology adds to efficient traffic management continues to increase. TMCs are needed to leverage the investments made in the State's transportation system.

As the technology progresses and enables interaction through data sharing with regional and local jurisdictions, transit agencies, and other state agencies, it becomes increasingly important to allow these stakeholders to work side-by-side. This movement toward sharing facilities is not unique to California. Other states and metropolitan regions are implementing TMCs. However, the sheer volume of traffic in California's urban areas and the number of lane miles the TMC staff manage means there is little happening in other states comparable to the situation that California faces. The Federal Highway Administration has conducted studies of TMCs but concludes "studies to date have yet to separate the benefits of a transportation management system itself from the benefits of housing the system in a center."[2] The benefits of system management are clear, as demonstrated in this report and in the fact that the national and international trend is toward the implementation of multi-jurisdictional TMCs. TMCs support system management.

Day-to-day, minute-by-minute management of the primary aspects of traffic control, incident management and traveler information occurs through the TMC. The Department is legislatively required to support the Statewide Emergency Management System (SEMS), and that support is provided through the TMC. Thus, during emergencies such as flooding, earthquakes, fires, civil unrest or terrorist attacks, TMCs are a vital piece of ensuring the safety of the California traveling public by providing a single place for those most involved in ensuring traveler safety to work as a team. The benefits of co-location are demonstrated clearly through real life outcomes. For example, in 1998, severe flooding washed out a bridge on Interstate 5 and water stood ten feet over the pavement in some places. The TMCs provided the mechanism through which Department districts and CHP could work to close the road by turning on CMS and helping to establish roadblocks despite hard rains and pitch black conditions. Soon after all traffic was diverted to State Route 99, that route also became flooded and traffic was diverted to local roads. Understanding where people were and the ability to communicate effectively made efficient deployment of departmental staff and CHP possible. A major flood that could have been a worse tragedy resulted in the loss of only three or four vehicles.

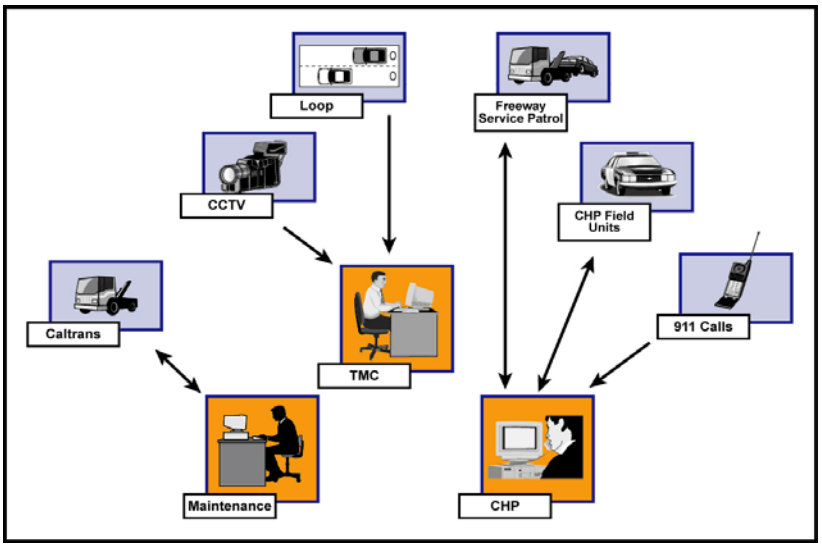
[2] Federal Highway Administration. *Transportation Management Center Concept of Operations: Implementation Guide*, 1999

The conditions under which co-location of State transportation management centers and local transportation management centers or CHP communication centers is cost effective and desirable can be summarized as follows:

- **Co-location with CHP** - The Department believes that all TMCs must accommodate a CHP presence. The extent of this presence varies, based on regional needs. For example, in smaller districts, co-location may consist of a single workstation for CHP to work side by side with the Department staff when circumstances dictate it, such as a major incident on the highway. In larger, urban districts, co-location may extend to the inclusion of a dispatch or communications center in the TMC. Factors that influence these determinations include the number of incidents, the overall traffic volume, vehicle mixes, and facility conditions. Generally, CHP presence should fall along the following lines:
  - at TMCs in rural areas, during major emergencies, heavy snow season
  - at TMCs in urban areas during peak periods
  - stand-alone TMCs must have 24-7 communication center

  Incident management and response requires the interaction and cooperation of the CHP – the manager of the scene – and the Department – the manager of the system, in real-time activity that has a direct impact on the lives and safety of travelers and responding personnel. Communication about an incident involves a variety of sources, as depicted in Exhibit III-1. In circumstances where CHP and the Department are co-located, when notification of a potential incident is received by the CHP, the dispatcher can request that a TMC operator activate the nearest CCTV, thus allowing the officer to quickly assess the situation and provide that information to the responding officer. The CHP dispatchers who are not located in a TMC do not have access to these images. Duplication of the CCTV systems in CHP centers would be prohibitively expensive. When the CHP and the Department are co-located, sharing vital information is easier and more direct, and thus less prone to delay and misinterpretation.

Exhibit III-1 Incident Management Information Flows



The circumstances for co-location with a CHP Communications Center are different than accommodation of a CHP presence. Co-location with a CHP communications center is desirable and cost-effective when:

- The CHP is willing to contribute funding toward the development of a building
- The Department would be implementing a 24 hour-a-day dispatch center anyway
- Freeway Service Patrol (FSP) is in use in the region, since the Department and CHP jointly support the FSP operations

- **Co-location with local jurisdictions** - The Department believes that it will become increasingly desirable to co-locate with local jurisdictions and that synergies will result in more effective management. However, it also believes that local jurisdictions should help fund new construction or rehabilitation of existing structures if they wish to avail themselves of the facilities. The full benefit of this co-location is not yet realized, as the technologies to share data, and hence improve traffic flow, are not fully developed. Nonetheless, it is exactly now that the Department must move to create a shared environment so that when the applications are integrated, each jurisdiction has not made significant expenditures in individual facilities and is unwilling to abandon that investment. Where co-location is a priority for the regional jurisdiction that is accompanied by financial commitment from the regional or local partners, thus ensuring cost-effectiveness in construction, the Department is committed to partnering with them. For example, the San Bernardino region is currently pursuing the development of a new TMC and has a commitment for local funding for half of the construction costs. TMCs must be designed to accommodate actions and activities anticipated for the future, and thus co-location with local agencies now is centrally important.

The Department does not believe that co-location, when implemented as described above, increases the costs associated with TMC development or operations. TMCs in urban areas generally have a 24-7 hour communications center and are designed to meet Emergency Services Act (ESA) codes. This design is not to allow the CHP to have a presence there, but because in the event of a large-scale natural disaster or other major disruption of power, it is imperative to public safety that the Department be able to control field elements such as CCTVs and CMS. Once the building has been completed, the CHP and all other participating agencies will be required to pay a portion of the rent and other services.

IV. Approach

The TMS Master Plan was developed, as directed by the budget language, in coordination with CHP and regional partner agencies. The coordination efforts included:

- **Regional Meetings:** The Department held five meetings around the State (in San Diego, Los Angeles, Oakland, Fresno, and Sacramento) to discuss system management as a whole and the TMS in particular. In each case, the Department's staff and representatives presented the plan for developing the Master Plan and obtained advice and guidance from a variety of stakeholders, including Metropolitan Planning Organizations (MPOs) and County Transportation Commission representatives.

- **Policy Advisory Committee:** A committee was formed to provide policy guidance to the Department in its efforts to develop the TMS Master Plan. The committee included management representatives from the Department (e.g., planning, operations), CHP, regional agencies, county agencies and other stakeholder groups. The group met to discuss updates on the project and provide feedback and direction to the Department.

- **Steering Committee:** A second committee was formed to provide management oversight and strategic direction to the TMS Master Plan team. The committee included district representatives from the Department's Division of Traffic Operations and CHP.

- **Working Groups:** Several working groups were formed to discuss more detailed technical issues and potential solutions. The groups included the Department's day-to-day practitioners in TMS, Department planning and maintenance representatives, CHP, as well as regional and local agencies as appropriate.

The messages the Department heard from its regional and local partners varied significantly. Some skepticism was communicated by some regions, especially at the early stages of the TMS Master Plan efforts. The comments reflect, in part, the difficult situation in which the Department finds itself.

The Department must satisfy federal regulations, sometimes differing regional priorities, and still develop and implement a cohesive statewide plan. With a large State like California, it is often difficult to address the needs of diverse stakeholder groups.

Over the last several years, Department staff gained valuable experience with TMS technologies. The Department will continue to develop its staff to understand, plan, operate, and maintain these technologies better. As part of the master planning exercise, the Department has identified opportunities for improvement, which are described in detail in the next section. The experience gained over the last decade must be leveraged and developed further to improve future performance.

As shown in later sections of the TMS Master Plan, every effort was made to address concerns raised by regional partners and position the State for TMS implementation. Development of the TMS Master Plan followed a systematic, objective process that included:

- A review of current TMS processes and the identification of shortcomings and opportunities for improvement.
- A business planning effort to develop the blueprint for each TMS process.
- A performance measurement effort to devise a framework to track and report on each TMS business process and therefore establish accountability.
- A financial plan to stage the TMS Master Plan implementation based on expected benefits and funding scenarios.
- A standardization plan to ensure consistency among districts and partners, and leveraging technology advances.

V. Major Issues

A comprehensive review was performed for the major TMS business processes. A large report is available upon request and includes detail process maps, descriptions of processes and sub-processes, cost information, and a list of opportunities for improvements. This list was further refined and addressed by the business plans, each plan addressing one TMS process. Overall, the process review suggests that the three TMS processes supported by solid detection have not yet been implemented consistently across the State. The major issues and opportunities identified are discussed below in three categories. Although they may hold true in many parts of the State, issues and opportunities may not be appropriate for particular regions.

Issues Related to TMS Field Elements

TMS field elements that relate to the three TMS processes under review include: detector stations, changeable message signs (CMS), closed circuit televisions (CCTV), controllers, highway advisory radio, and weather warning stations. Each performs a specific function important to the overall success of one or more TMS processes.

Over the years, the Department and its partners invested heavily in field equipment on the State Highway System. However, these investments were not always leveraged appropriately for a number of reasons, including:

- **Equipment Reliability:** Some of the field elements do not operate or communicate with TMCs properly. Reasons for the lack of reliability differ and include wear-and tear, inadequate maintenance, unreliable communications links or inadequate funding for communication requirements. It is essential that the Department address equipment reliability to be able to leverage past investments fully.

- **Coverage:** As all current field equipment gets repaired and connected properly to the TMCs, it still does not cover the full extent of the urban freeway system. Additional deployment is needed to address TMS data needs. Until that time, comprehensive strategies cannot be implemented. The Department must meet its needs in concert with others and look to the private detection community for initiative, involvement and entrepreneurship.

- **Technology Options:** Emerging technologies are raising the question of whether the Department is deploying the best detection technology. The Department currently relies on inductive loop detectors for detecting vehicles and calculating speeds on its freeway system. Newer technologies such as radar are deemed by some to be better since they do not reside under the pavement and may be easier to maintain and repair. Conversely, some tests suggest that the data from such technologies are less accurate. The Department should establish a methodology for continuous review of technology options as it moves to full system detection coverage. This methodology should allow for new technologies to be deployed if they are deemed superior in terms of performance and full life cycle costs.

Issues Related to Software Systems

A host of software systems performs critical functions for each TMS process. For ramp metering, software receives data from the field and adjusts ramp-metering rates based on pre-set and pre-tested algorithms that maximize the productivity of the freeway lanes. For traveler information, central software analyzes and summarizes real-time field data, posts it to the web for customers, and shares it with regional partners and commercial concerns for further dissemination and distribution. For incident management, central systems allow TMC staff to view incidents and understand the impact of incidents and inform the public and the media of expected delays and routing options. It also allows for faster action to clear incidents appropriately.

Many of these systems have not yet been fully developed. Some have been developed as stand-alone systems and must be integrated to work optimally. For instance, ramp metering systems and arterial signal management systems must be integrated in order to achieve the full benefits of each. However, the majority of the building blocks for such development and integration have been completed.

These systems are only now being implemented in the same manner across the State. Districts have relied on different software at times. More recently, the Department has decided to standardize these systems and must now fully develop and deploy these systems in a uniform manner to reap the benefits of consistency, including, but not limited to, more efficient system maintenance costs.

Issues Related to Coordination with Regional/Local Partners

The Department recognizes that future TMS deployments depend largely on coordination and cooperation with regional and local partners. In order to implement advanced TMS strategies, the Department must work closely with regional and local agencies to evaluate the impacts of such strategies on local roads and streets and mitigate them as appropriate. Moreover, under current State law, 75 percent of the State Transportation Improvement Program (STIP) is under the control of the regional agencies.

In the short-term, it is unlikely that funding for TMS will increase substantially. Many of the TMS processes depend on the customer, the traveling public. Regional and local agencies need to reach the public, inform the travelers of their options and explain the impacts of TMS in order to gain public acceptance based on a shared concern for customer satisfaction.

VI. Goals and Objectives

Restoring lost capacity (i.e., improving productivity) is the Department's most critical goal for the TMS. Full implementation of the TMS and complementary regional and local efforts will yield at least 20 percent improvements in freeway productivity in severely congested areas and a commensurate reduction in travel time delays. However, even though the Department would like to start implementation immediately and aggressively, it recognizes that several building blocks must be completed first.

The Department must demonstrate to State decision makers, regional partners, local agencies and the public that it is addressing the issues identified in Section V. Moreover, it must complete its system development efforts (e.g., central control software), evaluate the effectiveness of advanced algorithms and strategies, and develop corridor-specific system management plans in coordination with other agencies. These work elements take time and dedicated resources. The Department is committed to completing them in the short term and within current budgeted levels. The Department is not looking for nor making new financial commitments at this time. It must concentrate on full compliance with IT regulations and complete the detailed plans necessary for feasibility studies and corridor agreements. Once completed, the Department envisions a period of aggressive deployment of TMS corridor-by-corridor across the State until system productivity can be restored to more acceptable levels. As a result, the goals of the TMS Master Plan activities are divided into two implementation horizons. Both phases will occur within the full purview of the State and Regional budgeting and programming processes and no fiscal commitments will be made outside of those processes.

Short-Term Horizon

Timeframe: Three to five years *Goal*: Prepare for and support aggressive TMS implementation *Actions*: Address opportunities for improvement, ensure a minimum level of deployment, leverage past investments fully, and prepare for more aggressive deployment

The Department will tackle the issues discussed in the previous section by bringing all field elements to a state of good repair and reliability of at least 90 percent. The Department will ensure that the equipment communicates properly with management software and systems and provides access to real-time and historical information for partner agencies and private enterprises. The Department will complete its system development efforts consistently across its districts. The Department will also fill the gaps in detection on major congested corridors to the extent feasible and work with regional and local agencies to implement at least some TMS strategies on these corridors.

The Department will also work and coordinate with regional and local agencies that want to pursue more aggressive strategies. Regions that have been more aggressive and successful with TMS implementation will not be held back. Over the short term, the Department will work with regional and local agencies to develop more detailed system

management plans for congested corridors and conduct public outreach efforts so that more substantial benefits can be achieved shortly thereafter.

The Department will implement a performance measurement and reporting system and share its contents with partner agencies on a periodic basis.

Longer-Term Horizon

Timeframe: Seven to nineteen years
Goals: Restore lost capacity (i.e., increase productivity) by 20 percent
Reduce projected freeway congestion by 20 percent
Improve travel time reliability by 10 percent
Actions: Deploy aggressively and report continuously

The Department will seek accelerated funding for aggressive TMS deployments consistent with the system management plans. These plans, based on current analysis, will yield conservatively a 20-percent or higher reduction in delay with a commensurate improvement in productivity and a 10-percent improvement in reliability.

To achieve these benefits, the Department will increase its field element coverage, implement proven TMS strategies, and integrate its systems with local agencies. For each system management plan, the Department will collaborate with regional and local agencies to identify benefits, report on the progress achieved towards these benefits, and prepare pragmatic cost plans and schedules for implementation. The Department will work with State, regional, local agencies, and the private sector to identify ways to expand TMS funding from the current baseline of $50 million per year.

The funding levels required for this second phase will be around $75 to $150 million per year. The acceleration could come from a variety of sources. For capital investments, these sources include a combination of increases to the State Highway Operation and Protection Program (SHOPP), Regional Transportation Improvement Program (RTIP), or Inter-regional Transportation Improvement Program (ITIP). The support budget for the Department would need to be augmented to address the maintenance and operations needs of additional, deployed elements.

Performance Measures

Specific objectives and performance measures to quantify progress towards these goals are summarized in the Table VI-1 for detection and each TMS process. Additional performance measures have been defined for internal management and day-to-day analyses by practitioners. These are available for review upon request.

Table VI-1: Objectives and Performance Measures

TMS	Objective	Rationale	Performance Measure
Detection	Maintain field detection to achieve at least 90 percent reliability.	A high level of reliability is needed to support TMS functionalities. With a maximum of 10 percent un-reliability, current systems can estimate the conditions based on historical patterns. The benefit cost analysis assumes 90 percent reliability to be achieved in three years.	Reliability percentage by detection station, by facility, and by region.
	Increase detection coverage on urban freeways to 100 percent.	As per the Department's deployment methodology, priority will be given to congested freeways. However, 100 percent coverage will be critical for incident management and traveler information processes and the full cost of this coverage is included in the benefit cost analysis.	Percent of urban freeway system covered.
Traffic Control	Increase productivity on State Highway System by 20 percent.	Twenty percent was derived from the simulation efforts conducted as part of the benefit cost analysis.	Flow rates (vehicles per hour per lane).
	Improve mobility (reduce recurrent delay) on State Highway System by 20 percent.	Twenty percent was derived from the simulation efforts conducted as part of the benefit cost analysis.	Hours of delay experienced, excluding incident delays and including ramp wait times.
	Reduce accidents around freeway ramps by five percent.	Five percent was the lowest estimate from any ramp metering study conducted in and out of the State.	Number of accidents in urban areas.
Traveler Information	Provide simple access to detection data by partners and value added resellers.	Simple access will reduce the Department's costs of sharing its data and will enable partners and value added resellers to automate their data collection work.	Ease of access to detection data (via survey).

Table VI-1: Objectives and Performance Measures (continued)

TMS	Objective	Rationale	Performance Measure
Traveler Information	Increase geographic and modal coverage.	As the system coverage expands, so will the utility of the State's and the regions' traveler information systems. One hundred percent coverage and associated costs were used in the benefit cost analysis.	Percent of system covered.
	Increase use of traveler information provided to the public.	Increased use reflects information reaching the travelers and a proxy for travel behavior changes.	Number of Internet site hits, number of non incident-related messages displayed in the field.
Incident Management	Reduce incident-related delays by five percent.	Five percent was derived from the simulation efforts conducted as part of the benefit cost analysis.	Hours of delay experienced due to incident delays.
	Reduce secondary accidents (quantifiable objective to be determined).	Current tools do not provide a technical way to estimate the reduction in secondary accidents.	Number of accidents.
	Improve travel time reliability (predictability) by 10 percent.	Ten percent was derived from the simulation efforts conducted as part of the benefit cost analysis.	Percent variation of travel time for major origin destination pairs.
	Improve the State's security preparedness by increasing the visual coverage of urban freeways to 100 percent.	As per the Department's deployment methodology, priority will be given to congested freeways. However, 100 percent coverage will be critical for incident management and for security preparedness.	Percent of urban freeway covered by closed circuit television equipment.

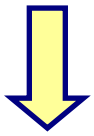
VII. Customer Impacts

The anticipated results of this TMS Master Plan and complementary efforts by regional and local agencies are illustrated by a typical travel day for a daily commuter. In this example, Jane Traveler generally commutes by automobile. Like many Californians, her morning travel experience starts at home and ends at work. As each segment of her trip is described, compare today's experience with the experience envisioned for the future with full multi-jurisdictional TMS implementation.

The Home Experience

Today: Jane Traveler has "a feel" for how long her trip will take on average. However, she is anxious, as on most days, since this "average" rarely holds true. Too often, her travel time varies from one day to the next and can sometimes take twice as long as usual. The culprit is often an accident on a busy freeway that she frequently uses. However, sometimes, the trip takes significantly longer without any apparent reason.

Jane has learned to listen to the radio and watch TV before leaving home. The media provides valuable information about conditions on the freeway, but very little on the many city streets and State arterials leading to the freeway. Only in rare instances, when very serious accidents are reported, does she drive a different route to work. She sometimes considers using a bus that gets her close to work, but she has no way of comparing her travel time on bus versus the highway for a particular day. Finally, Jane leaves home, hoping for the best.



After Full TMS Implementation: Jane Traveler logs onto the Internet and gets real-time information about her trip. She gets a current estimate of the travel time from her house to work. The web site notes that the estimate is valid unless an accident occurs in the next few minutes. The travel time estimate includes all segments of her trip, not just the freeway. When accidents are reported, the web site automatically provides alternative options and estimated travel times for each option. Jane is able to compare travel options by mode and route. Now, she can compare total travel time for automobile and bus transit on a daily basis. Moreover, if desired, the web site suggests the best time for travel. In some cases, it even suggests that Jane delays leaving home for 30 minutes. Although she will get to work 15 minutes later, she will save almost 15 minutes driving. Depending on her work commitments, Jane sometimes stays home longer to read the paper and save the 15 minutes. Jane can use a public web site or one of the more sophisticated private sites that tailors its information to its users. Jane makes her choice and leaves home less anxious and better informed.

What has enabled this change?

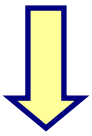
- Reliable and complete detection systems that provide real-time data to the Department, its partners and private value added resellers.
- Advanced traveler information systems that are easily accessible and can be tailored to the individual.
- Most travelers have gotten accustomed to the Internet and use it frequently.

The Local Streets and State Arterials Experience

Today: Jane Traveler backs out of her driveway and onto the local street network. She does not know or care about the distinction between city streets, county roads, and State arterials. She heads towards her freeway ramp. It seems to Jane that her drive on the streets varies significantly from day to day. Sometimes, when she "catches" the traffic lights just right, she can travel the entire length of the street without stopping more than once. However, when she is in the middle or near the end of a line of cars, she ends up stopping at multiple lights, adding time and frustration to her trip.

Jane listens to the radio for traffic updates, although by this time, it is hard for her to figure out how to change her route. Radio stations often alert her to accidents on the freeway she travels, but the stations do not give her specific information about the impacts of these accidents on her overall travel time.

The same type of experience is repeated once Jane exits the freeway system on her way to work.



After Full TMS Implementation: Jane Traveler pulls out of her driveway and onto the local street network. Now, she fully expects an optimized drive on the local streets. She knows that any incremental delays on the streets are due to ramp meter coordination. In fact, Jane already knows how long her drive to the ramps will take given the information she reviewed before leaving home.

Jane does not stop at several traffic signals before entering the freeway. The lights seem to adjust to her and others' travel patterns. She rarely stops at more than one light per street. Jane arrives at her selected ramp, which may differ from day to day depending on the route she chooses after reviewing information at home. In some cases, Jane gets tailored information during her trip from a private service that warns her of changes in travel conditions and her best options given these changes. Overall, Jane is better informed and more empowered because of more information.

The same, improved experience is repeated once Jane exits the freeway system on her way to work.

What has enabled this change?

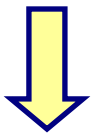
- Deployment of mid-block detection on State arterials and possibly local streets to optimize traffic signal schemes for platoons of cars.
- Different jurisdictional signal systems are integrated to optimize overall travel time and improve the predictability of travel.
- Arterial signal systems are integrated with ramp metering systems.
- Tailored traveler information is available during the drive (e.g., via cell phones).
- Most travelers have gotten accustomed to the Internet and use it frequently.

The Freeway and Freeway Ramps Experience

Today: Jane Traveler gets to her freeway on-ramp, which is usually metered during her daily commute. She waits for less than a minute on the ramp. She frequently questions the value of such metering, since the stop-and-go traffic on the freeways seems to start almost immediately after the meter light.

Once on the freeway, Jane experiences her daily, frustrating drive. In total, she travels only 12 miles on the freeway, but it takes more than a half hour. Jane listens constantly to traffic updates on the radio, hoping that today will not be one of the bad days. It seems to her that the freeway is always slowest just before an on-ramp, where cars start changing lanes hoping to find the fastest one.

A message sign on the freeway sometimes tells Jane about an accident ahead and says to "expect" delays. The radio also mentions the accident and provides an estimate of when the accident will be cleared with some limited re-routing options. Jane finally drives off the freeway, noting that she spent more than 35 minutes on the freeway, almost ten minutes longer than the day before.



After Full TMS Implementation: Jane Traveler gets to her selected freeway on-ramp based on the information obtained before leaving home and possibly updated during her drive on the local streets. She knows that the wait time at the ramps will be approximately five minutes. She remembers how the ramp wait was less than one minute just a few years ago. But now, the additional wait time on the ramps translates into significant time savings on the freeway. What used to take on average 30 minutes now takes no more than 20 minutes. Moreover, the information obtained at home and sometimes during her drive on local streets helped her select the ramp that provides her with the lowest overall travel time door-to-door. Jane remembers her original opposition to aggressive ramp metering. However, a public information campaign convinced her it was worth a try. Although she is still frustrated by the ramp wait times, Jane is thankful for the reduction in travel time and predictability of her daily commute. Once on the freeway, the speeds are almost constant, rarely dropping below 35 miles per hour.

Accidents are still reported on the message signs. Now, the signs also post an estimated delay. She can adjust her daily schedule if needed. Furthermore, she sometimes receives tailored information on her best alternative for travel. Some days, she parks her car at the nearest transit station and uses transit to avoid excessive delays. Jane also notices that accidents seem to be cleared faster than a few years before and that the additional delays due to these accidents are shorter. She remembers hearing that video cameras on the freeways have helped the authorities to respond to accidents faster.

What has enabled this change?

- Reliable and complete detection systems.
- Successful public information campaign to market the merits of ramp metering.
- Appropriate ramp metering implemented.
- Closed circuit television equipment deployed throughout urban freeway system to enable faster verification of and reaction to accidents. The equipment also serves the State's security preparedness needs.
- Tailored traveler information is available during the drive (e.g., via cell alarms).
- Most travelers have gotten accustomed to the Internet and use it frequently.
- Ramp metering and improved incident management have improved reliability of travel times.

The last three pages illustrate the benefits to an "average" traveler. It is meant to show the importance of reduced travel times and increased predictability in travel times for all Californians.

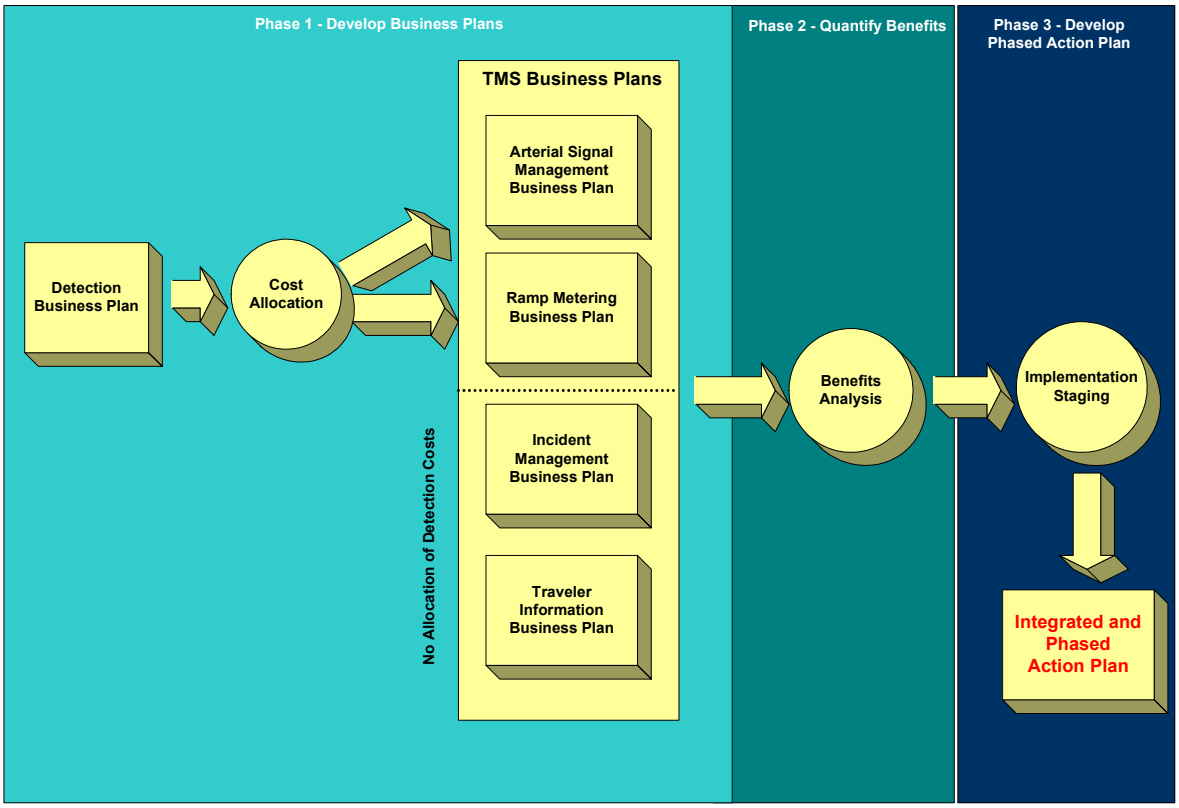
TMS implementation brings additional benefits, including: increased safety and security, the ability to measure and compare the impacts of different investments based on actual performance and the knowledge of trends in real-time information. This information can be provided to decision makers who are able to adjust strategies as appropriate.

The next section quantifies many of these benefits from a system-wide perspective and presents a detailed action plan for achieving these benefits. Underlying all these analyses and benefits though is the focus on increasing the productivity of the transportation system. All actions directly or indirectly contribute to productivity gains, improved mobility and predictability of travel time, and increases in safety for travelers.

VIII. Action Plan

The Department has developed an action plan based on the two implementation horizons discussed in the goals and objectives section. Developing the action plan required the three phases of analysis and synthesis depicted in Exhibit VIII-1.

Exhibit VIII-1: Phases of the Action Plan Development Process



Phase 1: Develop Business Plans

In the first phase, the Department reviewed existing operations business processes and engaged in business planning efforts that culminated in the development of TMS-specific business plans. A stand-alone business plan was developed for detection in recognition of its importance for every TMS process.

The Department developed five separate business plans for incident management, arterial signal management, ramp metering, and detection. Each business plan contains recommendations for improvement, an action plan for implementing the recommendations, and the costs of these actions. The action plan is summarized in Table VIII-1.

Table VIII-1: Summary of Action Plan

Process	Recommendation	Rationale
Detection	Ensure that detection is maintained at the highest level possible.	Detector data have not been consistently available. The Department should address this shortcoming as soon as possible, which will improve the TMS processes..
	Implement the TMS Deployment Methodology, including mid-block detectors for arterials and ramp and mainline detectors for the rest of the State Highway System.	Detection data are critical for all TMS business processes and for overall system management. A deployment methodology document defines the criteria for detection deployment.
	Implement an asset management system for field elements.	Field elements are costly and critical. An asset management system will help ensure proper installation, maintenance, and replacement.
	Formalize a testing and approval process for detection technologies.	Prior to deploying any new technologies, the Department tests the equipment in the operating environment to determine if, and under what specific circumstances, a particular technology can be deployed.
	Complete the communications infrastructure.	Dependable communication between TMCs and field elements is crucial. Without it, the Department cannot leverage its investments in field elements.
Incident Management	Improve working relationships with partners continually. • Strengthen inter-agency resource partnerships. • Deploy Incident Management Response Coordination Plan.	Multiple agencies work together to manage incidents safely and expeditiously. Strengthening inter-agency partnerships and developing incident response plans will help reduce clearance time and increase safety.
	Enable better management practices. • Implement automated incident management support tools. • Improve management information.	The Department and its partners need a centralized system for gathering, disseminating and reporting incident information. The system should standardize reporting, and retain incident clearance times and performance measures, giving the Department a better understanding of incident management performance and potential improvements.
	Expand use of tools to increase safety and clearance times. • Expand the use of Freeway Service Patrol (FSP). • Deploy more CMS and Closed Circuit Televisions. • Develop automated Highway Advisory Radio control system. • Investigate use of emerging technologies to decrease investigation time.	Expanding the use of tools would speed up the process of verifying and responding to incidents, which are estimated to cause half of the congestion delay experienced by travelers. Saving a few minutes per incident yields significant benefits. CMS help inform travelers who in turn can divert to alternate routes.

Table VIII-1: Summary of Action Plan (continued)

Process	Recommendation	Rationale
Ramp Metering	Expand corridor-wide adaptive ramp metering. • Implement the universal ramp metering protocol. • Prepare for Model 2070 controller. • Convey the benefits of ramp metering. • Conduct demonstration projects.	Several congested corridors do not have any ramp metering. Others that do can benefit from adopting enhanced corridor-wide ramp metering algorithms. To achieve these benefits, technology must be upgraded and skepticism regarding ramp metering must be overcome.
	Share data. • Allow local jurisdictions to see ramp metering rates. • Exchange data between freeway and arterial management systems. • Implement inter-district data sharing.	Ramp metering must be integrated with local signal control systems so that signals and ramp meters are coordinated. For corridors that cross district boundaries, it is important to share data among such districts.
	Develop knowledge management and experience leveraging mechanisms.	As the complexity of ramp metering grows, it is important to share successes and failures.
Arterial Signal Management	Implement advance signal actuation strategies. • Retire outdated software. • Upgrade communications to support performance measurement. • Prepare for predictive control strategies. • Prepare for Model 2070 controller.	Control systems managing arterial signal actuation can improve significantly with additional detection, communication and software development investments. These improvements will help detect platoons of cars and reduce their wait times at signals.
	Share data. • Implement interoperable arterial management systems. • Exchange data between freeway and arterial management systems.	The State operates only a small part of the arterial systems. Therefore, its systems must be integrated with locally controlled systems and with ramp metering systems to manage traffic flows optimally.
	Develop knowledge management and experience leveraging mechanisms.	As the complexity of arterial signal management grows, it is important to share successes and failures.

Table VIII-1: Summary of Action Plan (continued)

Process	Recommendation	Rationale
Traveler Information Systems	Standardize interaction with Information Service Providers (ISPs).	The Department is committed to provide traveler information through three different mechanisms: directly (retail) to the customer, via partnerships with regional agencies, and via value added private sector resellers. By standardizing interactions with ISPs, the Department can better serve its partners and minimize costs of such efforts.
	Develop multi-modal, trip-planning capabilities.	Developing the trip planning tool will improve the Department's web sites for travelers.
	Establish single-point distribution of data.	Districts provide data currently to value added resellers. By centralizing this function statewide, these private companies do not have to contact multiple districts to obtain statewide information.
	Implement rural 511 multi-modal system.	The Department is the only agency that can extend this system to rural areas.

Each action in the table includes many detailed activities. These activities are listed in the integrated schedule attached to this section and include efforts such as: developing Feasibility Study Reports (FSRs) for software development, developing Requests for Proposals, and implementing a public information campaign.

Once the business plans were developed, detection costs were allocated to arterial signal management and ramp metering based on primary use. For instance, urban highway detection equipment costs were allocated to the ramp metering TMS process because the technologies selected and the total number of detection stations was based on data needs for ramp metering.

The same applies for arterial detection costs, which were allocated to arterial signal management. The incident management and traveler information processes do not bear any of the detection costs, even though these TMS processes will also use the information provided by detection systems. This step was necessary in order to estimate benefits and costs and avoid double counting.

Phase 2: Quantify Expected Benefits

The recommendations for each TMS process were evaluated using a combination of simulation models and extrapolation models. The results were compared to observed traffic conditions in California and around the rest of the country as validation. The benefits were estimated based on a full, life-cycle analysis over twenty years.

This effort was extensive and used very conservative assumptions. Table VIII-2 shows the steps undertaken and the assumptions used throughout this phase. The benefits discussed in the rest of this section are also conservative and attainable.

Table VIII-2: Steps to Quantify TMS Benefits

Steps to Quantify Benefits	Conservative Assumption (if any)
Select two routes (I-680 in the Bay Area and I-405 in Orange County) for simulation.	Routes were selected to ensure that a less congested route (i.e., I-405) is included so that the benefits are not exaggerated.
Calibrate base simulation models and obtain forecasts from regional agency models.	
Quantify benefits of TMS strategies.	Safety benefits observed for ramp metering and incident management TMS processes were not addressed by simulations and not included, even though national experience suggests the benefits could be large. Some recommendations include investments in incident prevention, such as Highway Advisory Radio (HAR) and Regional Weather Information Systems (RWIS). Although the costs were included, the benefits were not.
Validate against real-world and reported results in California and the rest of the country.	Benefits were validated to be at the lowest range of observed and reported results.
Extrapolate statewide results.	Only peak-hour benefits were included, even though many of the congested routes already experience more than one hour of severe congestion. Safety benefits were also excluded from the overall benefits.

Phase 3: Develop Phased Action Plan

The benefits derived from the second phase were compared to the costs contained in the business plans and an implementation prioritization scheme was developed. This scheme was used to integrate the business action plans into a comprehensive TMS action plan. The action plan is attached as a schedule of activities at the end of this section.

Note that all benefit cost ratios were calculated incrementally, representing the incremental benefits estimated divided by the incremental costs for each strategy. In general, the conclusions of the benefit-cost analysis can be summarized as follows:

- For all congested corridors that have no ramp metering currently, successful implementation of a **simple adaptive** scheme provides the highest return on investment. Other, more sophisticated ramp metering strategies cannot be implemented before the investment in ramp meters and upstream detection is completed. All these investments are allocated to the simple adaptive ramp metering strategy.

The simple adaptive scheme is the least restrictive form of ramp metering and avoids ramp queue backups. It does so by accelerating meter rates when ramps are backed up with vehicles. It may also be the most acceptable option to local agencies that are skeptical about the benefits of ramp metering. Ramp meters and ramp detection equipment must be installed on the entire corridor. The benefit-cost ratio for this investment is 11 to 1. The total incremental life cycle costs allocated to this strategy are approximately $270 million and the life cycle benefits are estimated to be almost $3 billion.

- For all congested corridors on which simple adaptive ramp metering has already been implemented, significant benefits could be achieved by **optimizing meter rates** while still avoiding ramp backups. This requires department staff to analyze each ramp and set of ramps to derive the optimal meter rates and adjust their current configurations accordingly. This step does not require any incremental capital costs, although it does require significant research and analysis. The benefit-cost ratio for this strategy is close to 17 to 1. However, it requires significant human resources to analyze and adjust ramp configuration rates continuously. Also, this strategy cannot be implemented before the simple adaptive ramp metering strategy is implemented first. The total incremental life cycle costs allocated to this strategy are approximately $30 million and the life cycle benefits are estimated to be almost $500 million.

- For severely congested corridors only that already have simple adaptive ramp metering and optimized meter rates, additional incremental benefits can be achieved by implementing an **extended adaptive scheme** or, better yet, a **corridor adaptive ramp metering scheme**. Both require additional investment in detection over and beyond the detection required by the simple adaptive scheme. However, the associated benefits far exceed the costs if implemented correctly. Both algorithms can be configured to minimize backups on the ramps. The benefit-cost ratio for these investments is 13.5 to 1. It requires additional investment in detection, but is very beneficial for corridors with multiple bottlenecks.

  The total incremental life cycle costs allocated to this strategy are approximately $270 million and the life cycle benefits are estimated to be more than $3.5 billion. This strategy yields these types of benefits only on severely congested corridors.

- Implementing **advanced arterial signal actuation strategies** also provides benefits that exceed the associated costs. However, the highest benefits are achieved when State-controlled arterial signals are integrated with locally controlled arterial signals and freeway ramp meters. This requires significant coordination and software integration efforts on the part of the Department and its local partners. The benefit-cost ratio for the associated investments is 4.5 to 1 and requires additional investment in arterial detection. The total incremental life cycle costs allocated to this strategy are approximately $120 million and the life cycle benefits are estimated to be more than $550 million.

- Implementing **improved incident management** yields lower benefits than the other strategies. However, given that safety benefits were excluded from the benefit-cost analysis, and given that the additional field equipment related to these improvements also yields benefits related to traveler information, security preparedness and AMBER alert implementation, it is still a valuable investment. Also, many benefits related to improved coordination, partnerships, communications, and training all provide benefits that are not included.

  The benefit cost ratio for the associated investments is approximately 3 to 1 and requires investments in closed circuit televisions and changeable message signs. The total incremental life cycle costs allocated to this strategy are approximately $1 billion and the life cycle benefits are estimated to be almost $3 billion

- Implementing **comprehensive traveler information** is only effective when the majority of a given region (e.g., county) is covered with detection, closed circuit televisions, and changeable message signs. The additional costs for sharing the data and developing tools to share information and travel options directly with the public are relatively small compared to the costs of deploying field elements. The TMS Master Plan assumes that the benefits for traveler information are not achieved until appropriate field element deployments are completed.

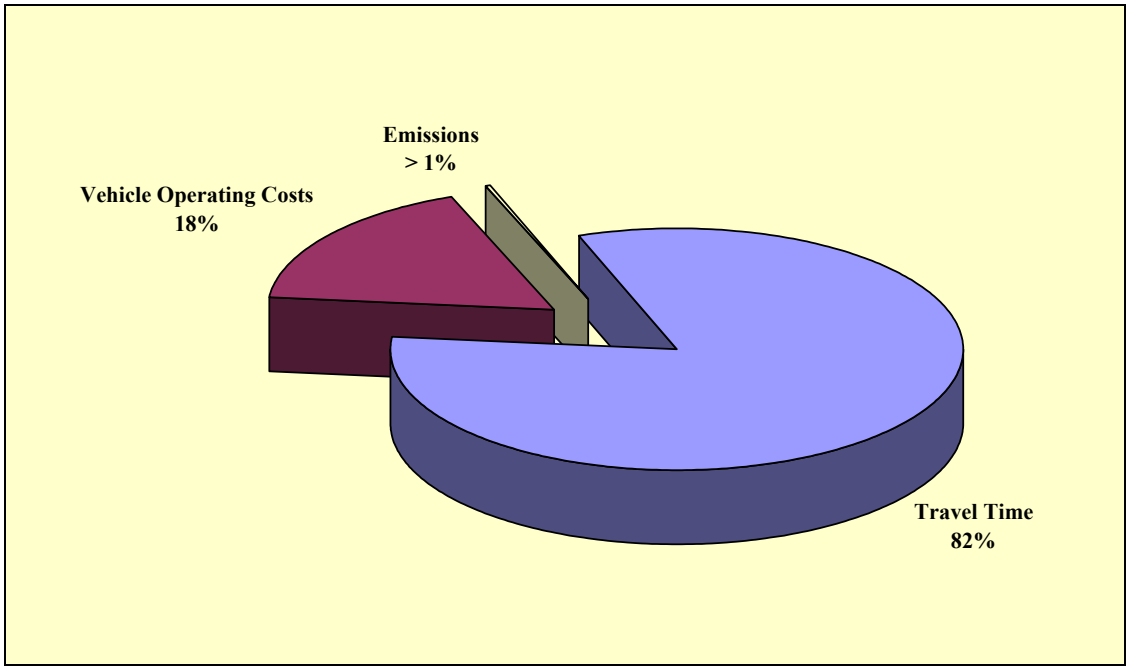
  The benefits of this investment far exceed its costs (over 100 to 1) primarily because it builds on investments allocated to the other TMS processes. However, it requires almost full coverage of field elements before the benefits can be achieved. The total incremental life cycle costs allocated to this strategy are approximately $20 million and the life cycle benefits are estimated to be more than $2 billion.

Total Benefits and Costs

Full implementation of the TMS action plan takes a minimum of ten years starting in 2003 and yields a total benefit-cost ratio of 7.5 to 1. The distribution of these benefits based on a 20-year life-cycle analysis is presented in Exhibit VIII-2. Safety benefits were not included and benefits were counted for only the peak hour of travel.

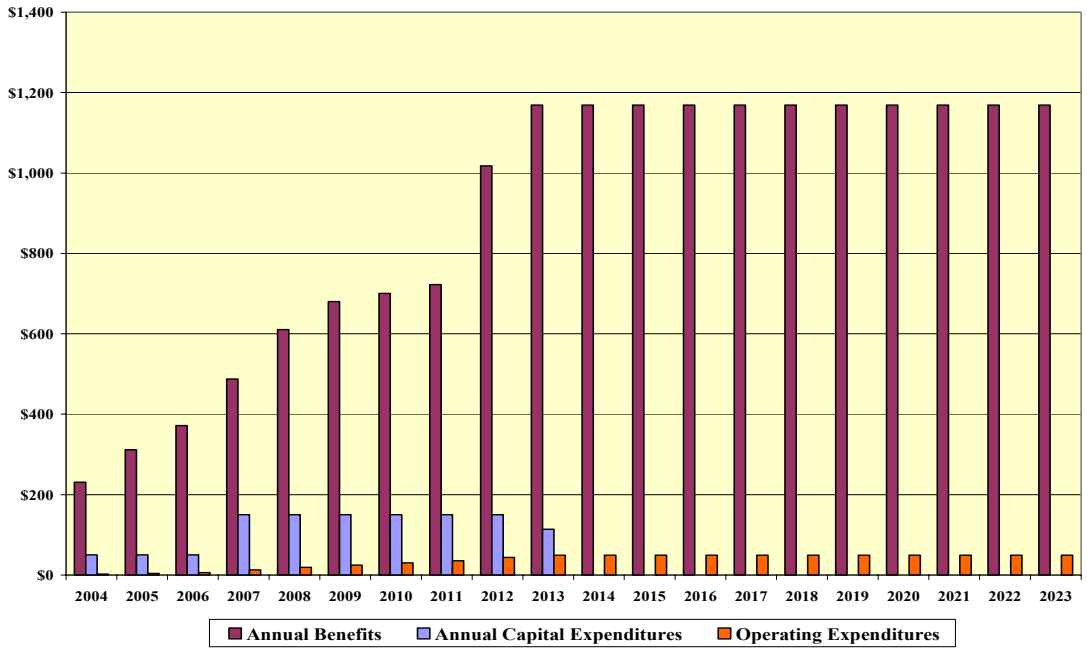
This conservative approach is meant to mitigate risks and ensure that the Department and its partners can meet these milestones. If the incremental funds (i.e., the $25 to $100 million increment over the $50 million current baseline) assumed to take effect starting in the fourth year of the implementation (i.e., in 2006) are not secured, targets will not be achieved and full implementation will take 24 years.

Exhibit VIII-2: Distribution of TMS Life-Cycle Benefits



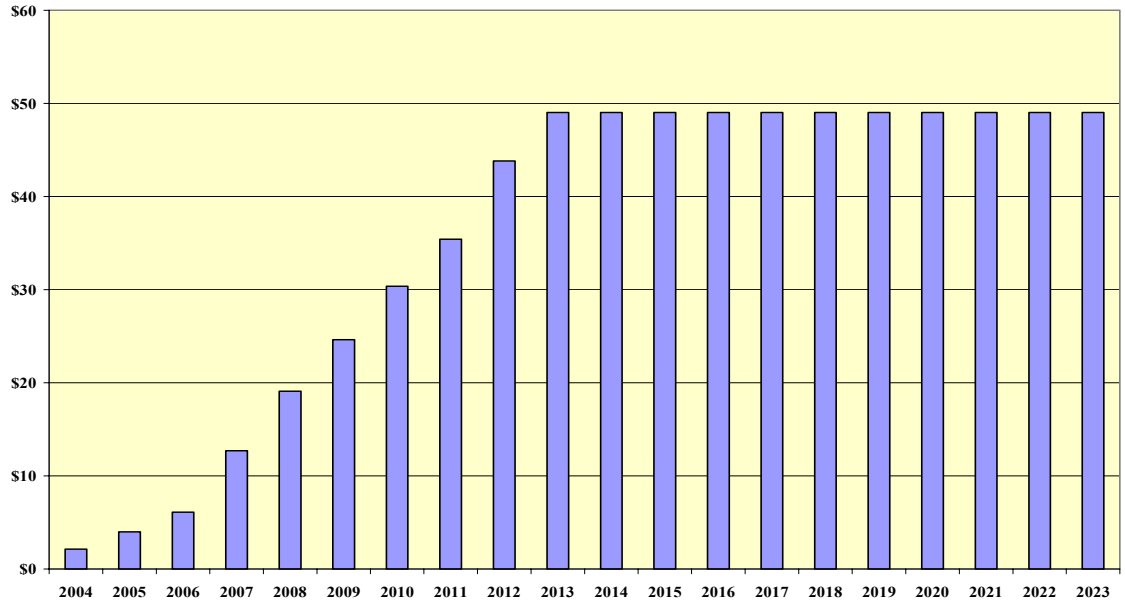
The annual incremental, non-discounted capital, operations (i.e., support and maintenance) expenditures, and benefits are shown in Exhibit VIII-3. Note that the capital costs shown here are completed in ten years assuming aggressive funding. Operating expenditures and benefits extend throughout the 20 years.

Exhibit VIII-3: Cumulative TMS Benefits (in $ millions) (assuming 10 year implementation)



The incremental non-discounted annual operations and maintenance costs are shown again in Exhibit VIII-4. These costs include replacement costs for the field elements and continue throughout the chart just like the benefits. Therefore, the benefits of TMS are expected to extend beyond even the time horizon of Exhibit VIII-3 without additional capital costs.

Exhibit VIII-4: Cumulative Annual TMS Operating and Maintenance Costs (in $ millions) (assuming 10 year implementation)



Implementation Risks

TMS improvements rely extensively on technology deployment and software development and enhancement activities. The Department is cognizant that any technology initiative carries a certain amount of risk. This is especially true for implementation of the TMS action plan, because in many cases, the Department cannot simply purchase off-the-shelf software. In these cases, the market place is not large enough to support private vendors. Moreover, the Department has already invested in technology elements and software and now needs to enhance them. Abandoning existing products would be very costly and delay implementation beyond the ten years suggested. Several risk mitigation efforts have been put in place to manage or mitigate these risks, including:

- **TMS Master Plan:** The Plan itself is a risk-mitigation tool. It provides milestones, detailed activity timelines, and expected costs and benefits. This allows the Department and its partners to gauge progress and act quickly if deviations occur. It also presents, for the first time, a comprehensive view of the entire spectrum of activities needed to reach the goals and objectives.

- **Standardization:** The TMS Master Plan development efforts included the formulation of a Department standardization plan. The Standardization Plan modifies and extends the previous Standardization Plan to reflect current thinking with respect to a host of standardization issues. The principal aims of the Standardization Plan are to reduce the higher development and maintenance costs that can result from a lack of standardization, and to provide guidance concerning the migration to standardized approaches throughout California. The approach used by this Standardization Plan is to separate the TMS into fundamental components. It recognizes that the details of operational functionality, the placement and mixture of components and choice of deployment technologies will change over time and with different local application requirements. Nonetheless, the basic components and their interfaces should not change. Changes to the hardware and software components of the TMS must be controlled and documented through a configuration management process.

  The Standardization Plan establishes a component architectural framework for standardization. This framework defines certain high-level system structural and inter-component communications requirements that will allow standardized components to act individually or in combination to achieve the TMS Master Plan goals. Deploying standard TMS elements that meet the Standardization Plan's interface requirements will support modular system designs that are repeatable, and allow for flexibility in system design and the selection of equipment. With implementation of the Standardization Plan, the Department will achieve the following broad objectives:

  1. Maintaining a consistent approach to standardization across the various TMS components.
  2. Allowing for incremental component upgrades rather than wholesale or major system change-outs as technology changes.
  3. Promoting an "open systems" approach where future technology providers compete on products, technologies, and services to the benefit of the State.
  4. Aligning the Department's TMS solutions better to current evolving national ITS standards, State information technology (IT) standards, and industry norms. For much the same reasons that statewide TMS standardization makes sense, so does alignment with industry and general IT standards.

  Also with implementation of the Standardization Plan, at the highest level, the TMS infrastructure will evolve in the following ways:

  1. Move towards Internet Protocol (IP) based communications interfaces.
  2. Move towards National Transportation Communication Internet Protocol (NTCIP) messaging and object definitions.
  3. Encapsulation of individual hardware and software components as self-contained, loosely-coupled units.
  4. Move towards "thin-client" user interfaces.

As a whole, the Standardization Plan will minimize inconsistencies among districts, add discipline to software initiatives, and help meet national and regional standards, all of which help mitigate the risks of implementing the TMS Master Plan.

- **System Management Plans:** The TMS Master Plan is comprehensive and defines a phased action plan for implementation. However, the TMS Master Plan was developed from a statewide perspective and does not include a detailed plan for each corridor. It also calls for developing more detailed system management plans for corridors and regions that integrate corridor-specific TMS deployments with other elements of system management, such as operational improvements and expansion. Developing system management plans, co-led by regional and local agencies, adds one more level of risk mitigation to the implementation of the TMS Master Plan.

- **Demonstration Projects:** The TMS Master Plan recommends demonstration projects for ramp metering deployments. This recommendation mitigates the risk of public and local agency acceptance by conducting before and after studies for different types of corridors. Once these demonstration projects are completed, it should be easier to garner additional support.

- **Feasibility Study Reports:** The TMS Master Plan activities include the development of several FSRs. These reports are required by State policy, but also provide a means to assess fully each type of software development activity on its own and mitigate project specific risks.

- **Consistency among Districts:** The recommendations in the TMS Master Plan aim to provide increased consistency in systems and hardware among Department districts. As consistency is established, the risks associated with using different applications or deploying different technologies will be mitigated as well.

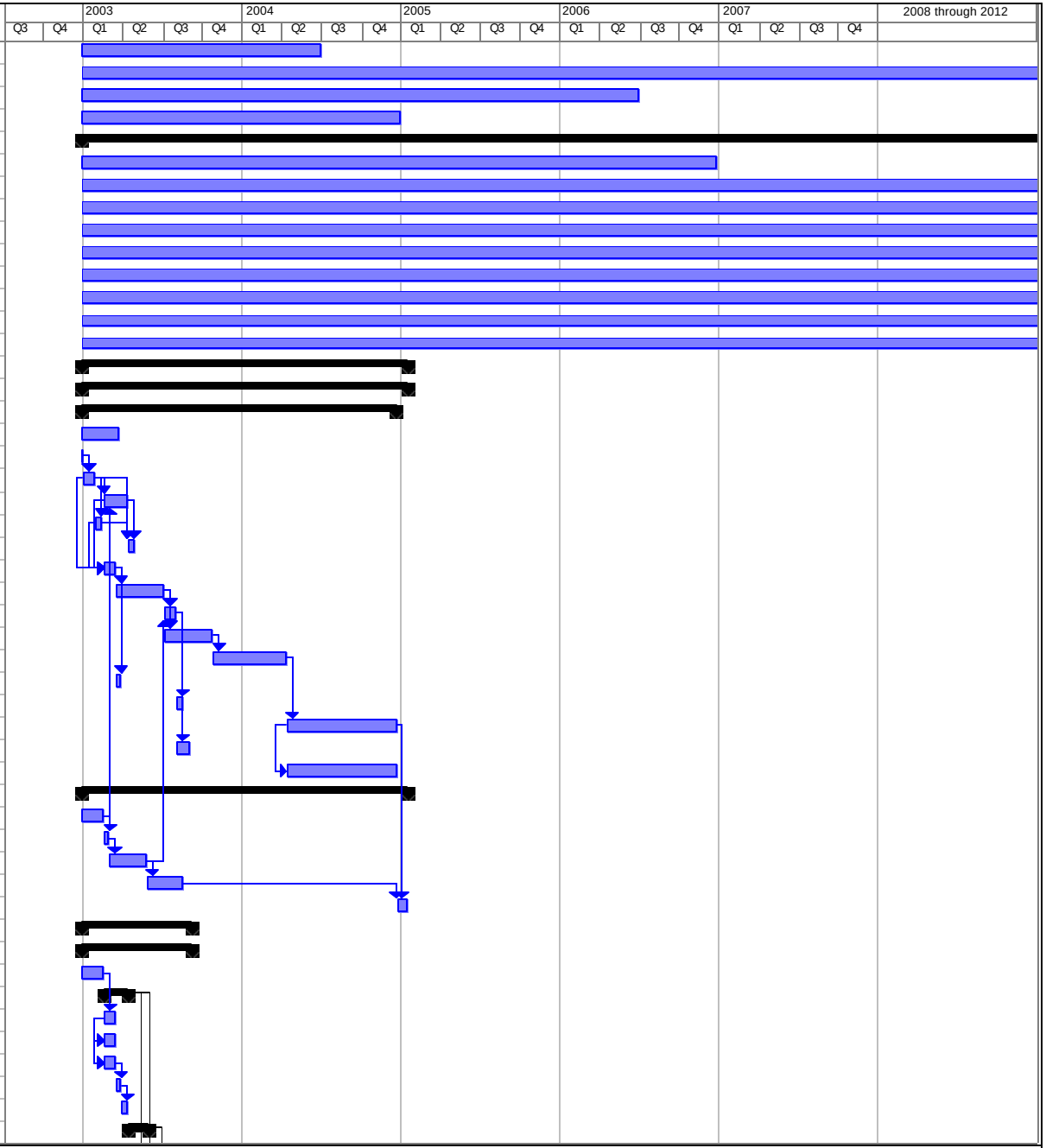
The benefits of TMS implementation are superior to many of the more traditional transportation investments. While investments in system expansion usually yield benefit-cost ratios of around 2.5 to 1, the Department estimates conservatively that the benefit-cost ratio of the TMS is 7.5 to 1.

The risks of not implementing this action plan far outweigh the risks discussed in this section. Without improving the productivity of the State's transportation system, congestion will grow much faster, benefits from expansion projects will diminish, and delays experienced by travelers will increase significantly.

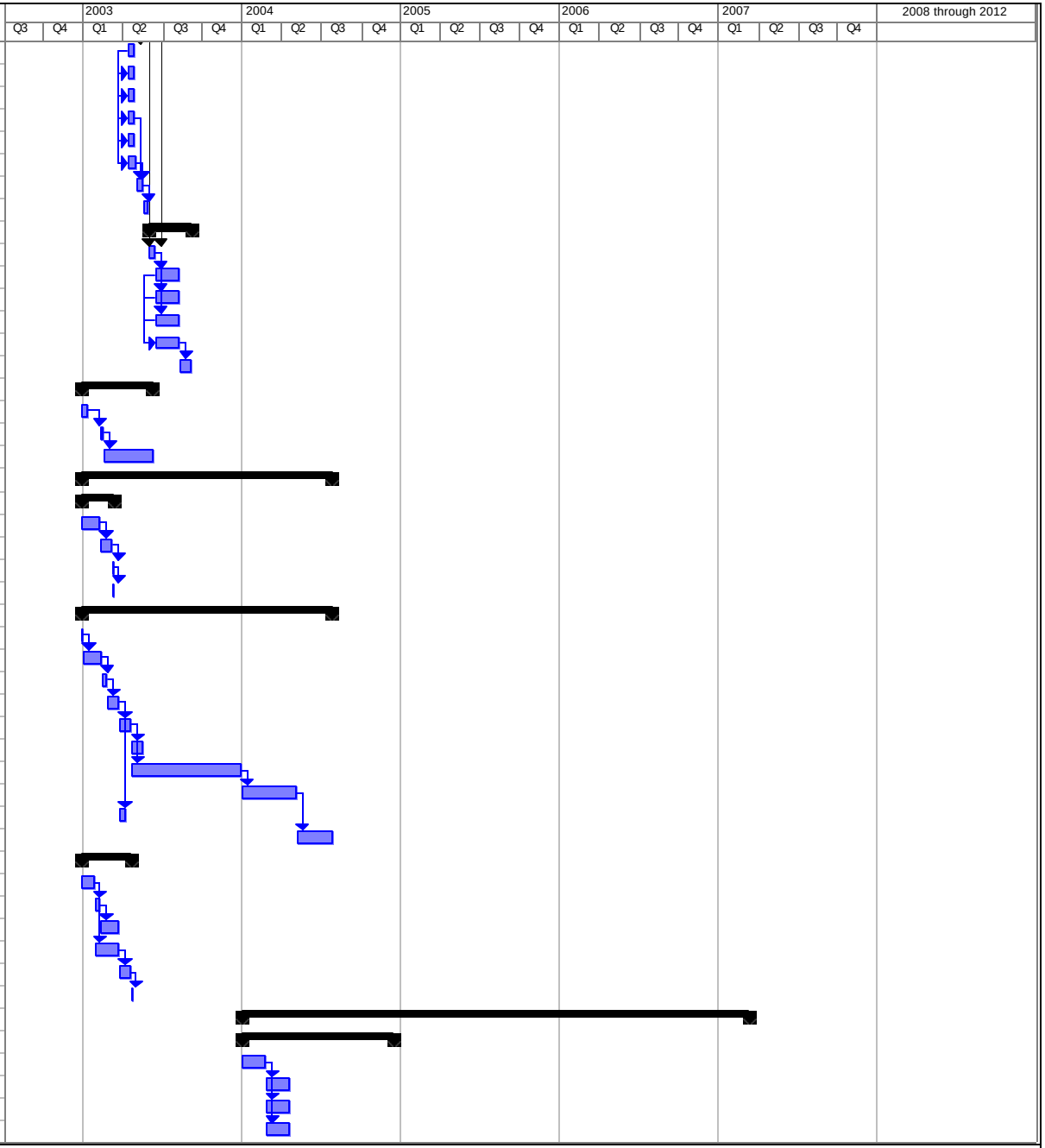
The Department is committed to implementing the TMS aggressively in cooperation with its regional and local partners. The attached phased action plan is realistic, addresses the regional agencies' feedback, and yields realistic and attainable benefits that Californians need. This action plan is a first step to be followed by many more details focusing on

individual corridors and regions. Updates on the progress towards the action plan will be provided to stakeholders and decision makers on a regular basis.

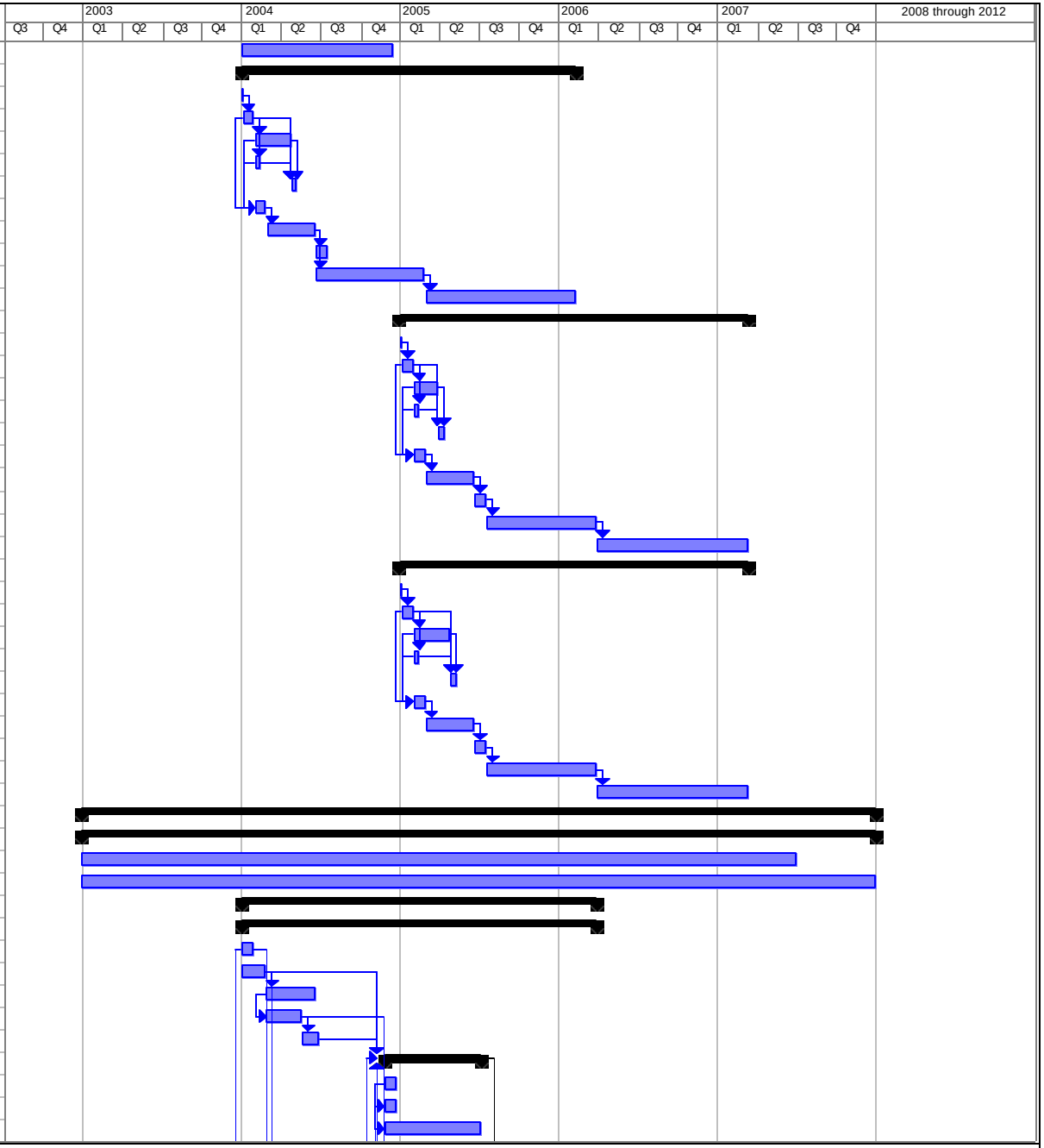
ID	Task Name
1	Bring All Field Elements to State of Good Repair and Reliability
2	Ensure Sufficient On-going Maintenance
3	Develop Corridor/Regional System Management Plans
4	Implement Performance Measurement and Reporting System
5	**Complete State Field Element Coverage**
6	Ramp Meters (implement deployment methodology)
7	Mainline detection (implement deployment methodology)
8	Arterial mid-block detection (implement deployment methodology)
9	Fiber Optics
10	Closed circuit televisions (implement deployment methodology)
11	Changeable message signs
12	Deploy CCTV (implement deployment methodology)
13	Deploy HAR(implement deployment methodology)
14	Deploy EMS
15	**Incident Management Implementation Tasks**
16	**Enable Better Management Practices**
17	**Implement Automated Incident Management System**
18	Deploy interim data collection mechanism
19	Meet with Configuration Control Board
20	Define scope of additional functionality
21	Define user and functional requirements
22	Define annual operations and support needs
23	Configuration Control Board approves project
24	Develop FSR for ATMS revisions
25	Await approval of FSR
26	Develop RFP for ATMS revisions
27	Acquire vendor
28	Complete revisions
29	Define District roll-out strategy
30	Prepare District implementation plan
31	Implement District implementation plan
32	Define training plan
33	Implement training plan at Districts
34	**Improve Management Information**
35	Define performance measurement data
36	Establish Incident Standardization Committee
37	Define standardized classifications and messages
38	Create consistent evaluation framework for Districts
39	Implement framework and reporting mechanisms
40	**Continually Improve Working Relationships**
41	**Strengthen Inter-agency Resource Partnerships**
42	Develop Inter-agency Coordination Team in each District
43	**Align Stakeholder Vision and Goals**
44	Define vision & goals for each agency re: incident management
45	Determine gaps and document impacts
46	Determine common vision and goals
47	Define gap between current situation and vision
48	Define & implement steps to eliminate gaps
49	**Develop inter-agency protocols**



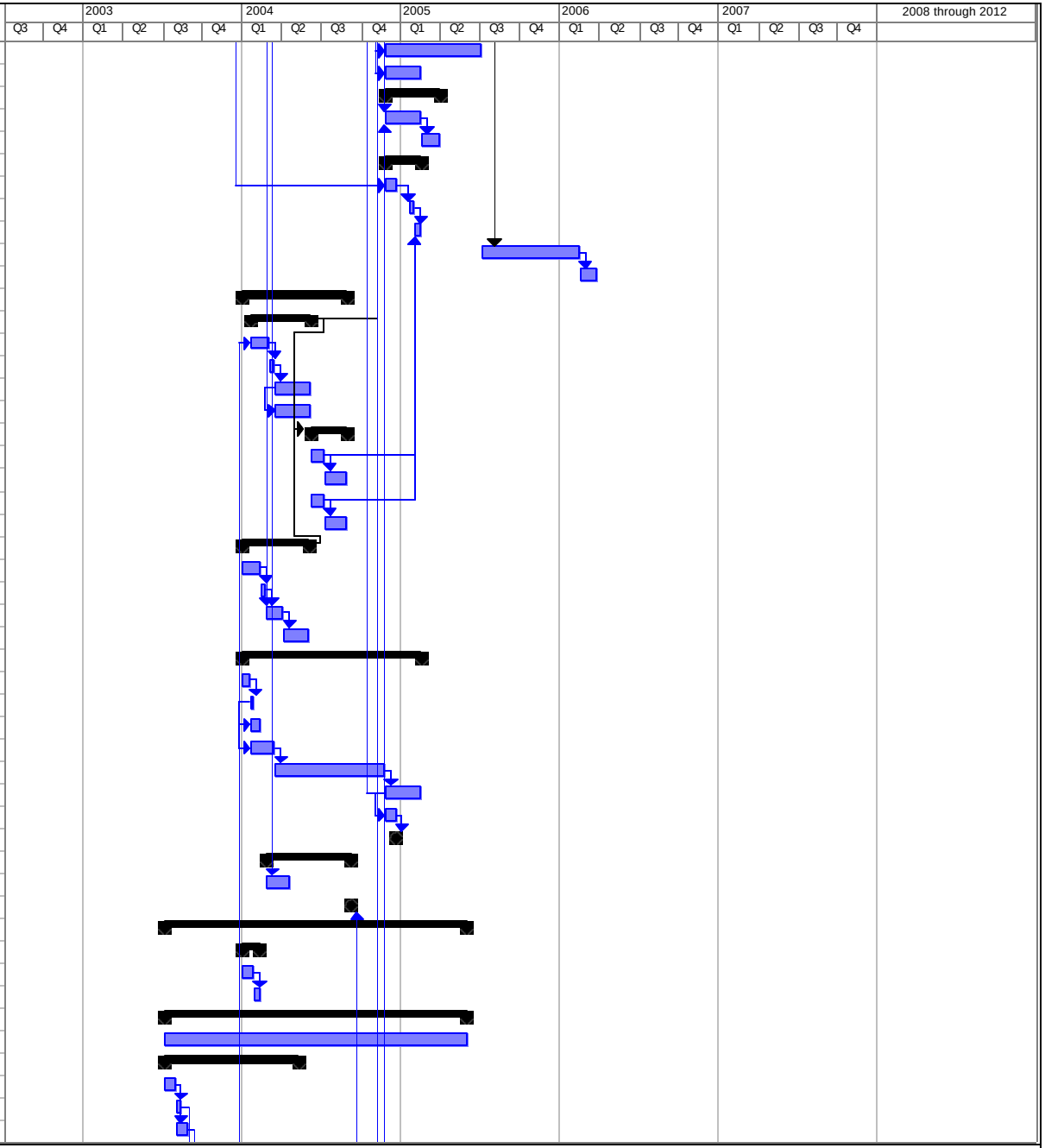
ID	Task Name
50	Review each member agency's response protocols
51	Determine where protocols conflict and why
52	Determine which protocol conflicts can be resolved
53	Resolve conflicts
54	Determine where protocols could be revised to enhance safety
55	Determine where protocols could be revised to reduce clearance time
56	Determine if specific new inter-agency protocols would be helpful
57	Define inter-agency protocols
58	**Develop Cross-Agency Training**
59	Determine agency staff targeted for training
60	Develop training on Align Stakeholder Vision & Goals
61	Develop training that reflects Inter-agency Protocols
62	Develop training to familiarize member agencies with TMC functions
63	Determine what additional training is needed
64	Implement training
65	**Develop Incident Response Coordination Plans**
66	Define relationship to the Regional System Management Plan
67	Attend FHWA training courses
68	Develop plans
69	**Expand Use of Tools to Increase Safety and Decrease Clearance Times**
70	**Expand Use of Freeway Service Patrols**
71	Determine funding strategy to increase funding
72	Define data to be collected to demonstrate success
73	Track performance (on-going)
74	Request additional funding when able
75	**Develop Automated HAR Control System**
76	Meet with Configuration Control Board
77	Develop user and functional requirements, including integration to ATMS
78	Configuration Control Board approves project
79	Develop FSR and request funding
80	Await FSR approval
81	Develop RFP
82	Acquire vendor
83	Develop system
84	Determine deployment priority
85	Deploy system
86	**Investigate Use of Emerging Technologies**
87	Define Pilot Oversight Committee
88	Define Pilot objectives
89	Define performance measures and success and failure criteria
90	Select application area
91	Determine if additional funding is needed; request as appropriate
92	Implement pilot application
93	**Traveler Information Implementation Tasks**
94	**Standardize Interaction with ISPs**
95	Define single point of contact
96	Define data presentation standards
97	Define roles and responsibilities
98	Define standard data use agreements



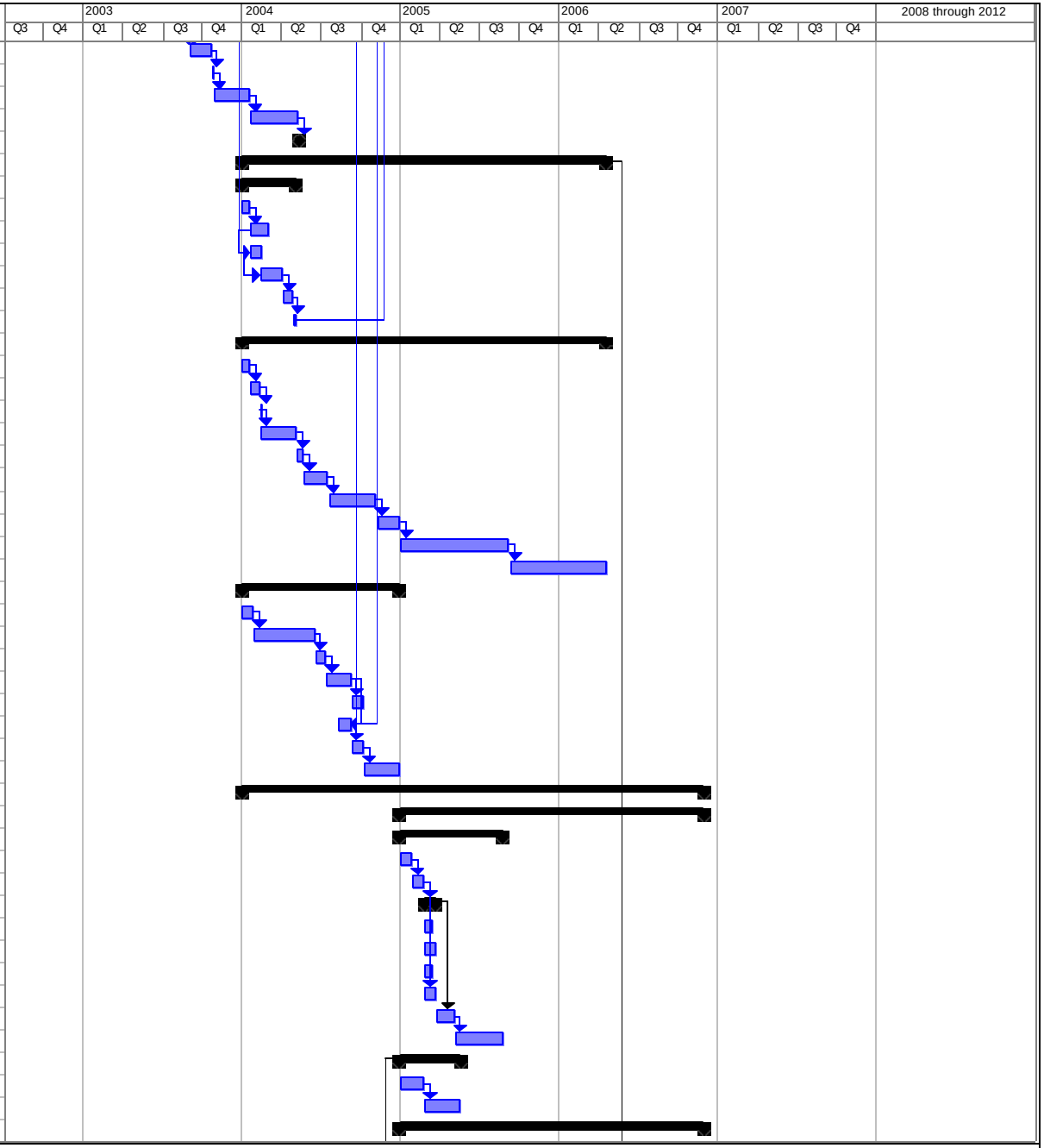
ID	Task Name
99	Implement new contracts
100	**Develop Multi-modal Trip Planning Capabilities**
101	Meet with Configuration Control Board
102	Define scope of functionality
103	Define user and functional requirements
104	Define annual operations and support needs
105	Configuration Control Board approves project
106	Develop FSR
107	Await approval of FSR
108	Develop RFP
109	Acquire vendor
110	Complete project
111	**Establish single point of data distribution**
112	Meet with Configuration Control Board
113	Define scope of additional functionality
114	Define user and functional requirements
115	Define annual operations and support needs
116	Configuration Control Board approves project
117	Develop FSR
118	Await approval of FSR
119	Develop RFP
120	Acquire vendor
121	Complete project
122	**Implement Rural 511 Multi-Modal Trip Planning**
123	Meet with Configuration Control Board
124	Define scope of functionality
125	Define user and functional requirements
126	Define annual operations and support needs
127	Configuration Control Board approves project
128	Develop FSR
129	Await approval of FSR
130	Develop RFP
131	Acquire vendor
132	Complete project
133	**Traffic Control**
134	**Ramp Metering Implementation Tasks**
135	**Implement Simple Adaptive Ramp Metering Locations**
136	**Optimize Simple Adaptive Ramp Metering Locations**
137	**Expand Corridor-wide Adaptive Ramp Metering**
138	**Demonstration Projects**
139	Complete compatibility testing ATMS/URMP
140	Select corridors for Demonstration Projects
141	Complete detector evaluation and upgrade as needed
142	Complete corridor software and hardware review and upgrade
143	Define Implementation Oversight team in each Corridor (chaired by MPO)
144	**Develop detailed implementation plan for each corridor**
145	Define roles and responsibilities
146	Define success criteria
147	Determine ramp metering algorithms



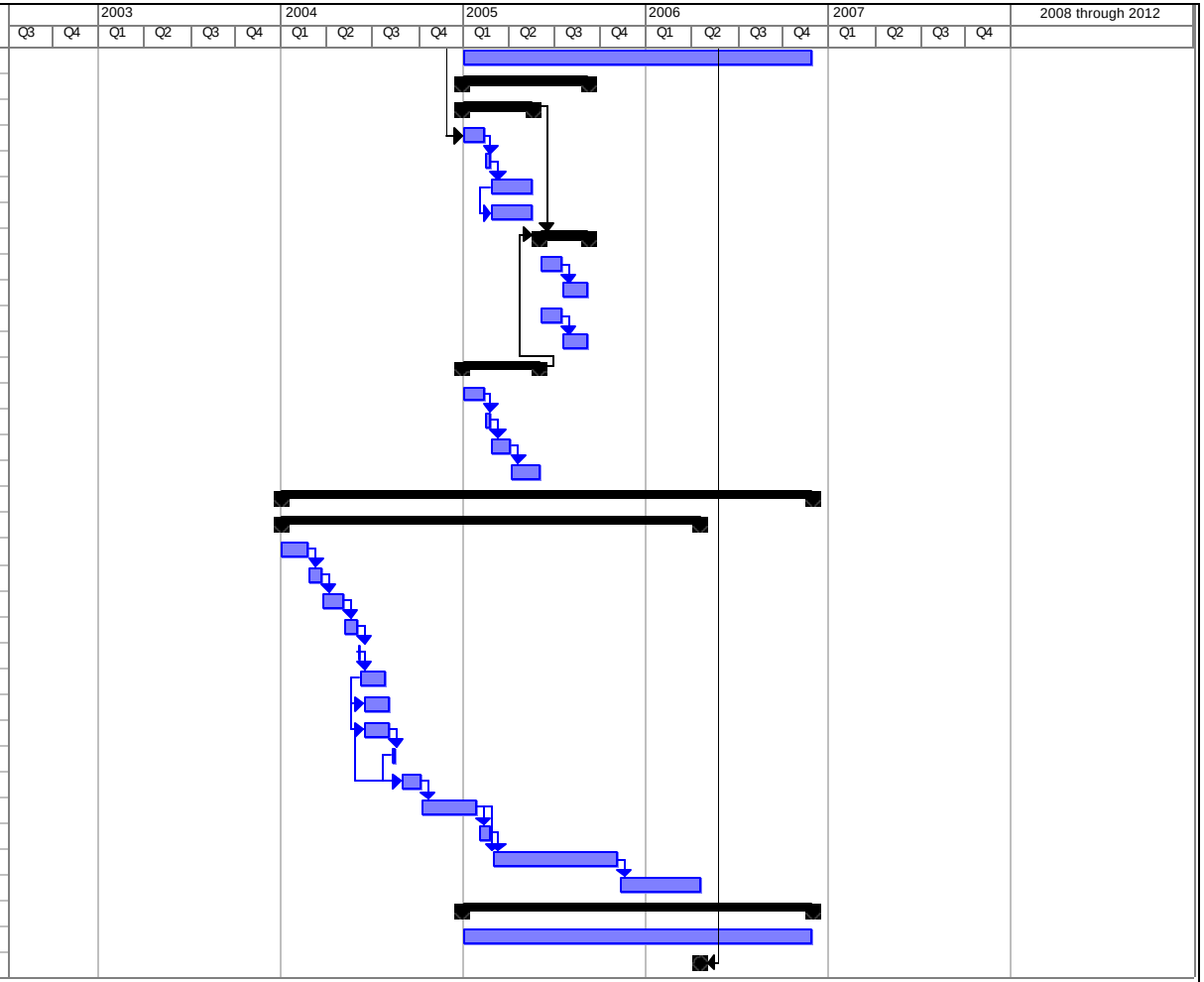
ID	Task Name
148	Determine arterial (state and local) strategies
149	Define data sharing mechanisms
150	**Implement Model 2070s**
151	Develop detailed 2070 implementation plan for each corridor
152	Implement 2070 implementation plan
153	**Universal Ramp Metering Protocol Training**
154	Develop training plan and documentation for URMP
155	Train District staff in URMP
156	Train District staff on Model 2070 Controllers
157	Implement detailed plan
158	Document and publish outcomes
159	**Model 2070 Controller Preparations**
160	**Documentation Review**
161	Review internal policies, procedures, guidelines and manuals
162	Create review and revision timeline
163	Review and revise documents
164	Create new documents as needed
165	**Staff Readiness**
166	Develop training plan for maintenance
167	Implement training plan for maintenance
168	Develop training plan for operations
169	Implement training plan for operations
170	**Software Preparedness**
171	Develop software testing plan
172	Define software testing environment
173	Implement software testing plan
174	Mitigate as needed
175	**Convey Benefits of Ramp Metering**
176	Define desired outcomes of Information Campaign
177	Define target audiences (local/regional decision makers and public)
178	Define success measures to measure outcomes
179	Develop RFP for Public Information Campaign vendor
180	Acquire vendor
181	Implement limited scale in targeted corridors
182	Measure success
183	Implement larger scale if successful
184	**Expand Implementation to Other Corridors**
185	Determine strategy for selecting other corridors for adaptive strategies
186	Implement additional Corridor Adaptive Ramp Metering Strategies
187	**Share Jurisdictional Data**
188	**Improve Local Jurisdiction Visibility into Ramp Metering Rates**
189	Develop approval process to establish View-Only work stations
190	As requested, implement work stations in local TMC
191	**Exchange Data Between ATMS and Arterial Management Systems**
192	Continue with research on integrated network technologies and algorithms
193	**Implement Inter-District Data Sharing**
194	Define where this functionality is desirable
195	Determine what critical short-term needs exist
196	Define where functionality will be needed in 10 years



ID	Task Name
197	Determine feasibility of software or hardware solution
198	Meet with Configuration Control Board
199	As needed, develop FSR and request funding
200	Await approval
201	Implement solution
202	**Develop KMS and Leverage Experience**
203	**Short-term**
204	Establish Policy & Procedures Review Team
205	Collect policies, directives, management memos, regulations, procedures
206	Review documents for consistency, accuracy, etc.
207	Revise documents as needed and obtain approval
208	To the extent feasible, convert to electronic media
209	Distribute all materials to appropriate Traffic Operations staff electronically
210	**Define Knowledge Management System Requirements**
211	Establish Knowledge Management System Core Team
212	Define parameters of KMS
213	Meet with Configuration Control Board
214	Define functional and business requirements for KMS
215	Configuration Control Board approves project
216	Develop FSR and request funding
217	Await approval
218	Develop RFP for KMS implementation
219	Acquire vendor
220	Vendor completes work
221	**Leverage Successful Practices**
222	Define Ramp Metering Practices Improvement Team
223	Team reviews practices in districts where ramp metering is successful
224	Develop "Success Indicators" -- those things that make projects successful
225	Define & document practices that support Success Indicators
226	Establish outcome review processes to update Success Indicators
227	Determine whether additional training is necessary
228	Disseminate Success Practices to Districts
229	Train as determined necessary
230	**Arterial Signalization Implementation Tasks**
231	**Advance Signal Actuation Strategies**
232	**Retire Outdated Software**
233	Meet with impacted Districts
234	Determine overall timeline (when will each District be converted)
235	**Define transition plan**
236	Define staffing impact at District and HQ
237	Define hardware impact (desktop and servers)
238	Define software impact
239	Define training plan
240	Implement training plan
241	Implement transition plan
242	**Upgrade Communications to Support Performance Measurements**
243	Develop upgrade plan for each district
244	Implement upgrade
245	**Prepare for Predictive Control Strategies (On-going)**



ID	Task Name
246	Continue research.
247	**Model 2070 Controller Preparations**
248	**Documentation Review**
249	Review internal policies, procedures, guidelines and manuals
250	Create review and revision timeline
251	Review and revise documents
252	Create new documents as needed
253	**Staff Readiness**
254	Develop training plan for maintenance
255	Implement training plan for maintenance
256	Develop training plan for operations
257	Implement training plan for operations
258	**Software Preparedness**
259	Develop software testing plan
260	Define software testing environment
261	Implement software testing plan
262	Mitigate as needed
263	**Share Jurisdictional Data**
264	**Implement Arterial Management Systems that are Interoperable**
265	Meet with Locals to secure support
266	Determine overall timeline
267	Define Working Committee that includes staff from Districts and local partners
268	Determine what software will be considered in the scope of the project
269	Meet with Configuration Control Board
270	Define user requirements
271	Define functional requirements to meet user requirements
272	Determine and document specific standards that will be used
273	Configuration Control Board approves project
274	Develop FSR and request funding
275	Await approval
276	Develop RFP for vendor
277	Acquire vendor
278	Vendor completes work
279	**Exchange Data Between ATMS and Arterial Management Systems**
280	Continue with research on integrated network technologies and algorithms
281	Develop KMS and Leverage Experience: Task Completed Jointly with Ramp Metering



Attachment A

SUPPLEMENTAL REPORTING REQUIREMENTS OF THE 2001 BUDGET ACT

6. Transportation Management Systems Master Plan: By September 1, 2002, the Department of Transportation (Caltrans), in coordination with the Department of the California Highway Patrol (CHP), shall submit to the Chair of the Joint Legislative Budget Committee, the chairs of the fiscal committees in each house, and the chairs of the transportation committees in each house, a draft Transportation Management System Master Plan. The plan shall include, but not necessarily be limited to, all of the following:

(a) A description of the current business processes for managing the transportation system and an assessment of current practices.

(b) Definitions of the roles and responsibilities of various entities, including Caltrans, CHP, and regional transportation planning agencies, with regard to incident management and recurrent congestion.

(c) A description of the conditions under which co-location of state transportation management centers and local transportation management centers or CHP communication centers is cost effective and desirable.

(d) A list of specific measurable objectives and performance measures for system management and how each element and strategy contributes towards those objectives.

(e) An action plan for improving traffic management that will ensure statewide consistency and coordination of transportation management center activities. After review and approval by the Department of Finance, Caltrans shall submit a final plan to the committee chairs specified in this provision no later than December 28, 2002.